



# Tackling The “Grand Challenges” With Super Supercomputers

BY JAMES SCHULTZ

In 1965 Gordon Moore, co-inventor of the microchip and co-founder of Intel Corporation, captured the imaginations of electronics aficionados worldwide with a bold prediction that computer circuitry would double in density and in power every 24 months. Moore's Law, as the axiom came to be known, has held for nearly 35 years. Now, as engineers continue a torrid pace of chip design, introducing dramatic improvements almost yearly, personal computers are beginning to best all but the brawniest machines.

But today's supercomputers are poised for quantum leaps of their own. As one-step-at-a-time processing gives way to parallel processing, a software approach that allows much faster calculation by parceling out tasks simultaneously to banks of microprocessors, new supercomputer architectures will likely achieve routine speeds of trillions of calculations per second. At present only a handful operate in this “teraflops” range. A decade hence, even teraflops computing may seem archaic as calculating speeds continue an astonishing acceleration.

“Ten years from now we'll be in the petaflops range — a million billion ‘floating-point operations’ per second,” predicts David Keyes, Old Dominion associate professor of computer science and an associate research fellow with NASA's Institute for Computer Applications in Science and Engineering. “It's computing for the so-called ‘Grand Challenge’ problems: weather prediction, human genome modeling, pollution dispersion, ocean circulation and so on. Petaflops computing is a big leap, but I think the technical challenges will be met.”

## The Meaning Of A New Machine

With unprecedented amplification in capability, super supercomputers may eventually, like intelligent machines immortalized in science fiction books and movies, listen to, understand and speak human language, accurately translating one language into another as it is spoken. Designers may also be able to create intelligent “software agents” that roam the Internet snaring and summarizing information from a vast ocean of data, delivering it to users

as requested. Sophisticated online simulations may also be generated: virtual, hyperrealistic scenarios that model the behaviors of complex systems like global climate and world financial markets.

Super supercomputers may also enable engineers to take fundamentally different approaches in the design and construction of still more powerful computers based on biological systems or those that operate on a subatomic level. Software developers could use ultrafast supercomputers to write more robust, reliable software to run and monitor increasingly complex telecommunications and power-generation systems.

For consumers, the advent of super supercomputers will likely have a ripple effect on personal computers. Home-based PCs will likely become more “transparent,” or much easier to use. No longer will buyers of new systems be required to master the intricacies of operating systems or spend hours puzzling out the secrets of bundled software.

For universities, the advent of super supercomputers should ratchet up in scale and scope educational resources available to faculty and students alike. Certain courses that may not have been available may be routinely so. In the case of nuclear engineering, for example, would-be graduates are required to have some access to a nuclear reactor — a relatively rare, complicated, potentially dangerous device that requires expensive safeguards and constant monitoring under controlled conditions. Few universities can afford their own.

But by observing a computer simulation, students will be able to track in detail nuclear fission and fusion, thereby gaining the same learning benefits that would otherwise come only with an actual reactor. Such simulations could radically improve courses and their content.

“A lot of educational software today simply repackages existing knowledge,” Keyes asserts. “High-capacity simulation development will enable learners to explore various scenarios. It will be a true exploration of unknown systems, systems that otherwise would be impossible to understand or predict.”

## Turbocharging The Net

As the pace of technology development accelerates, Keyes is among those expecting Old Dominion to stay comfortably current with innovation. While the true benefits of any advance become apparent only over time, he believes the university is well positioned to ride the crest of any foreseeable technological wave.

“Old Dominion is supple, not ossified. The university realizes the benefit of new technology,” Keyes explains. “It’s part of the culture here already, with such initiatives as TELETECHNET and IRI. Compared to many in the rest of the world, we try more things, faster and with a broader range of applications.”

Old Dominion is one of 130 universities nationwide that have joined the University Corporation for Advanced Internet Development (UCAID). UCAID’s university members have committed more than \$50 million per year in new funding for Internet2 — a far faster, vastly more efficient version of the

existing system — while corporate members have promised to provide nearly \$20 million over the life of the project.

The UCAID initiative is part of a broader effort to intensify and deepen the benefits of computer-related information technology. As part of its fiscal year 2000 budget, the Clinton administration has proposed a nearly 30 percent increase in the federal government’s investment in information technology (IT). This \$366 million initiative, known as IT2 — Information Technology for the Twenty-First Century — will support long-term information technology research intended to lead to fundamental advances in computing and communications, in the same way that 1960s-era government investment led to today’s Internet.

The agencies involved in IT2 include the National Science Foundation, the departments of Defense and Energy, NASA, the National Institutes of Health, and the National Oceanic and Atmospheric Administration. Roughly 60 percent of the funding will go to support university-based research, which will also help meet the growing demand for workers with advanced IT skills.

The intersection of these projects with petaflops computing could likewise boost the prospects for university-led innovation. In particular, the ensuing quality and wealth of information should result in more informed, capable graduates. Keyes predicts that when large-scale simulation is fully absorbed into curricula, 30-year-old students with Ph.D.s from universities like Old Dominion will have the functional knowledge of 1999-era 60-year-old professionals.

Yet he cautions prudence when viewing future prospects. Computers must be judged against a backdrop much broader than this or that breakthrough. In the long run, Keyes believes computer technology will not supplant education. Rather, it will help to support it.

“I’m not a computer utopian. We should be careful not to ignore the dangers of abandoning all the cognitive abilities we have developed in the absence of computers,” he urges. “There’s never been as efficient a way as encapsulating knowledge and facts as with computers. But they’re not a substitute for creative intelligence. Computers won’t replace traditional instruction. They will augment it.”



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