Project GreenLight

The information technology industry consumes as much energy and has roughly the same carbon “footprint” as the airline industry. Now scientists and engineers at the University of California, San Diego are building an instrument to test the energy efficiency of computing systems under real-world conditions - with the ultimate goal of getting computer designers and users in the scientific community to re-think the way they do their jobs.

The National Science Foundation is providing $2 million over three years from its Major Research Instrumentation program for UC San Diego’s GreenLight project. An additional $600,000 in matching funds comes from the UCSD division of the California Institute for Telecommunications and Information Technology (Calit2) and the university’s Administrative Computing and Telecommunications (ACT) group.

“As a leader in the field of information technology, UC San Diego has a responsibility to reduce the amount of energy required to run scientific computing systems,” said UCSD Chancellor Marye Anne Fox. “Project GreenLight will train a new generation of energy-aware scientists, and it will produce energy consumption data to help investigators throughout the research community make informed choices about energy-efficient IT infrastructure.”

http://greenlight.calit2.net

If we are going to continue to allow ourselves the benefits of advances in computing, we need to understand power and cooling requirements much better.

- Tom DeFanti, PI, GreenLight
The rapid growth in highly data-intensive scientific research has fueled an explosion in computing facilities and demand for electricity to power them. Energy usage per compute server rack is growing from approximately 2 kilowatts (KW) per rack in 2000 to an estimated 30 KW per rack in 2010. Every dollar spent on power for IT equipment requires that another dollar be spent on cooling—equivalent to double the cost of the hardware itself over three years. As a result, cooling and power issues are now becoming a major factor in system design.

Thomas A. DeFanti, a research scientist at Calit2 and principal investigator of the GreenLight project, notes that “scientists from all domains will choose more efficient systems as they invest in new cyberinfrastructure, and we expect that GreenLight will give them the data they need. Some scientific computing jobs need more powerful processors, some can do with less memory, some can use specialized processors: these are important requirements to understand so the optimally configured cluster can be chosen and scheduled through virtualization techniques each and every time.

The information technology (IT) industry has recently been estimated to have the same carbon footprint (that is, energy consumption) as the airline industry. Airlines have invested heavily for decades in more efficient engines, lighter airplanes and optimized scheduling to save energy consumption. Meanwhile, the energy usage per compute server rack has grown from about 2 KW/rack in 2000 to an estimated 30 KW/rack in 2010, to the point where the cooling and power issues are now a major factor in system design. In the last several years, the IT industry has begun to develop new strategies for “greening” traditional data centers, yet the physical reality of modern campus cyberinfrastructure (CI) is a complex network of ad hoc and sub-optimal energy environments in departmental facilities. But because the value of computational and data-intensive approaches to research is increasingly embraced, this number of departmental facilities is swelling fast and creating campus-wide crises of space, power, and cooling.

This GreenLight Instrument development will enable five communities of application scientists, drawn from metagenomics, ocean observing, microscopy, bioinformatics, and the digital media, to come to understand, through this instrumentation, how to measure and then minimize energy consumption, to make use of novel energy/cooling sources coming online at UCSD, and employ middleware that automates optimal choice of compute/power strategies. This will enable domain application researchers to continue to exploit the exponential improvements in silicon technology and compete globally.

Using OptIPuter and Quartzite methods developed under earlier NSF awards, computing clusters — truthfully inconvenient and energy-inefficient as now found in users’ labs — can be re-situated in pre-fabricated campus “machine rooms” where detailed measurements of energy efficiency can be made, but with the clusters still operated by their virtual “owners” remotely from their labs. Unfortunately, almost nothing is known about how to make these shared virtual clusters energy efficient, since there has been no financial motivation to do so. How can better power efficiency configurations and deeper architectures be researched and discovered? What can/should one teach the next generation of engineers who must scale from an education in computer science to a deep understanding in engineering physics, or vice-versa? As a step, a full-scale virtualized device, the GreenLight Instrument, will be developed to measure, monitor, and make publicly available, via service-oriented architecture methodology, real-time sensor outputs, thus allowing researchers anywhere to study the energy cost of at-scale scientific computing.

This Instrument will enable an experienced team of computer science researchers to make deep and quantitative explorations in advanced computer architectures, including alternative circuit fabrics such as Field-Programmable Gate Arrays, direct-graph execution machines, graphics processors, solid-state disks, and photonic networking. The enabled computing and systems research (see box on front) will yield new quantitative data to support engineering judgments on comparative “computational work per watt” across full-scale applications running on at-scale computing platforms. This will help re-define fundamentals of systems engineering for green cyberinfrastructure — a transformative concept.

For more, go to http://greenlight.calit2.net.


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