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Patrick Kurp

Green Computing

Are you ready for a personal energy meter?

ANDY HOOPER INSISTS he's not a utopian, but his vision of the future of computing shares some resemblances with the dreams of science-fiction writers.

He foresees a not-too-distant time when the world's sources of computing power are concentrated in remote server warehouses strategically located near the sources of renewable energy that power them, such as wind and solar farms. And the usage of the power sources could shift across the globe, depending on where energy is most abundant.

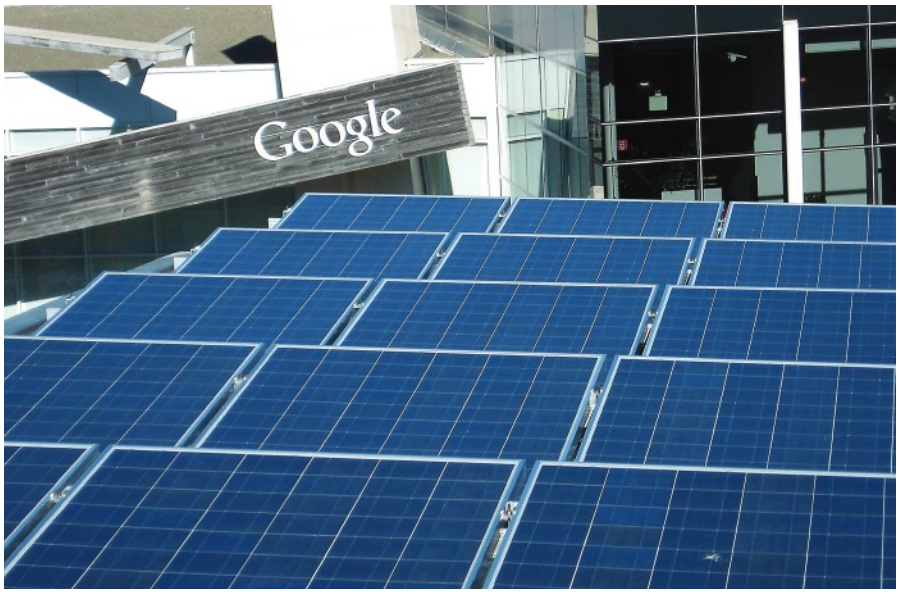
"The system we now employ is hugely wasteful," says Hopper, a professor of computer technology at the University of Cambridge and head of its Computer Laboratory. "We lose energy by relying on the national grid. I propose a system that is more efficient, much less expensive, and that would have an immediate impact on the world's energy consumption. It's always cheaper to move data than energy."

Hopper is among the more conspicuous and outspoken pioneers in the green computing movement—a multifaceted, global effort to reduce energy consumption and promote sustainability. Proposed and existing strategies range from the practical to the fanciful, and include government regulations, industry initiatives, environmentally friendly computers made of recyclable materials, and Hopper's suggestion of a personal energy meter.

Much of the green computing movement's focus today is on data centers, which have been lambasted as "the SUVs of the tech world" for their enormous and wasteful consumption of electricity. The approximately 6,000 data centers in the United States, for instance, consumed roughly 61 billion kilowatt-hours (kWh) of energy in 2006, according to Lewis Curtis, a strategic infrastructure architect at Microsoft. The total cost of that energy, $4.5 billion, was more than the cost of electricity used by all the color televisions in the U.S. in 2006, Curtis says.

The Department of Energy (DOE) reports that data centers consumed 1.5% of all electricity in the U.S. in 2006, and their power demand is growing 12% a year. If data centers' present rate of consumption continues, Curtis warns, they will consume about 100 billion kWh of energy at an annual cost of $7.4 billion by 2011.

The federal government wants data centers' energy consumption to be reduced by at least 10% by 2011. That translates into an energy savings equivalent to the electricity consumed by a million average U.S. households, according to Paul Sheathing, a spokesman for DOE's Office of Energy Efficiency and Renewable Energy.



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"There's no simple path to green computing, but there are some low-hanging fruit," Curtis notes in "Green: The New Computing Coat of Arms?", a paper he co-authored with Joseph Williams, the CTO of WW Enterprise Sales at Microsoft. "You can spin the dial on some straightforward actions, such as orienting racks of servers in a data center to exhaust their heat in a uniform direction, thus reducing overall cooling costs.... A comprehensive plan for achieving green computing really does require an architectural approach."

David Wang, the data center architect for Teradata, has specialized in thermal management solutions for the Miamisburg, OH-based data warehousing company since 1996. "I've raised the issue [of green computing] because, for me, it's both a business question and an ethical question," Wang says. "Look at the basic fact, the one that has to be addressed: Power consumption at the server level has increased along with performance increase, and business needs have grown even faster."

More attention must be devoted to data centers' ever-increasing power density and heat removal, Wang says. "In the past, the sole focus was on IT equipment processing power and associated equipment spending. The infrastructure—power, cooling, data center space—was always assumed to be available and affordable," he says. "Now the infrastructure is becoming a limiting factor."

Microsoft, Google, and Yahoo are addressing the environmental concerns about their data centers' carbon footprint, the measure of the environmental impact of an individual or organization's lifestyle or operation, measured in units of carbon dioxide produced.

Google uses customized evaporative cooling to significantly reduce its data centers' energy consumption.

In recent years, Microsoft and other companies have built data centers in central Washington to take advantage of the hydroelectric power produced by two dams in the region. The Microsoft facility, which consumes up to 27 megawatts of energy at any given time, is powered by hydroelectricity.

"This way, because we're so close to the source, we're not losing any energy and the energy we do use is pure and clean," says Francois Ajanta, Microsoft's director of environmental strategy.

Another Microsoft data center, located in Dublin, Ireland, is expected to become operational in 2009 and, thanks to Ireland's moderate climate, the 51,000-square-meter facility will be air cooled, making it 50% more energy-efficient than other comparably sized data centers.

Google "has committed to being carbon-neutral for 2007 and beyond," says Bill Weihl, Google's director of energy strategy. "Our carbon footprint is calculated globally and includes our direct fuel use, purchased electricity, and business travel—as well as estimates for employee commuting, construction, and server manufacturing at our facilities around the world."

According to Google, its data centers use half the industry's average amount of power. Google attributes this improved energy usage to the cooling technologies, such as ultra-efficient evaporative cooling, that the company has customized for itself.

Yahoo's data centers also went carbon-neutral last year, in part because of its use of carbon offsets.

Government regulations and industry initiatives are also tackling data centers' energy usage. The U.S. Environmental Protection Agency (EPA), for instance, should have its phase-one version of Energy Star standards for servers ready by year's end. Eventually, the server rating will measure energy use at peak demand, but for the purpose of getting an Energy Star rating under way, the EPA will first release a Tier 1 standard, which will measure the efficiency of the server's power supply and its energy consumption while idle.

Meanwhile, a global consortium of computer companies, including AMD, Dell, IBM, Sun Microsystems, and VMware, organized The Green Grid in 2007, with the goal of improving energy efficiency in data centers and business computing systems. To achieve that goal, The Green Grid collaborates with individual companies, government agencies, and industry groups to provide recommendations on best practices, metrics, and technologies that will improve data centers' energy efficiency.

Earth-Friendly Computers

As with any evolving idea, people will need to think differently and more deeply when it comes to green comput-

Data Mining

Consumers' Invisible Profiles

Health and life insurance companies in the U.S. are increasingly using consumers' prescription drug data to determine what type of coverage, if any, to offer applicants, the *Washington Post* reports.

The insurance companies hire health information services companies—such as Ingenix, which had $1.3 billion in sales last year—to help create consumer profiles. The health information services companies mine the databases of prescription drug histories that are kept by pharmacy benefit managers (PBMs), which help insurers to process drug claims. (Ingenix even has its own servers located in some PBM data centers.) The health information services companies also access patient databases held by clinical and pathological laboratories.

The health information services companies say that consumers have authorized the release of their records and that their approach saves insurance companies money and time. Privacy advocates note that consumers do sign consent forms authorizing the release of data, but they have to if they want insurance, and that many people are unaware of the existence of health information services companies.

ing. It is not unusual, for instance, for companies to replace their older computers with new, more energy-efficient ones in an effort to become more earth-friendly.

This practice might not always be the most environmental solution, says Teradata's Wang. "What I propose is that we look at the entire life cycle of a computer, the whole picture, from manufacturing through day-to-day operation," says Wang. "Every step consumes energy, and buying a new, more efficient computer may not always be the answer."

Some computer manufacturers are retooling their products from a life-cycle point of view and making the decision to buy a new, energy-efficient computer much easier. Dell is accelerating its programs to reduce hazardous substances in its computers, and its new OptiPlex desktops are 50% more energy-efficient than similar systems manufactured in 2005, thanks to more energy-efficient processors, new power management features, and other factors.

Likewise, Hewlett-Packard recently unveiled what it calls "the greenest computer ever"—the rp5700 desktop PC. The rp5700 exceeds U.S. Energy Star 4.0 standards, has an expected life of at least five years, and 90% of its materials are recyclable. The computer is easy to disassemble and meets the European Union's RoHS standards for the restriction of the use of certain hazardous substances in electrical and electronic equipment. Moreover, 25% of the rp5700's packaging materials are made of recycled material.

For the Future of the Planet

In an effort to ensure "computing can have a positive effect on our lives and the world," Hopper and Andrew Rice, an assistant director of research at the University of Cambridge's Computer Laboratory, have identified four principal goals in their paper "Computing for the Future of the Planet." The first goal is an optimal digital infrastructure in which computing's overall energy consumption is reduced and the efficient use of energy in the manufacture, operation, and disposal of computing devices is maximized.

The second goal is "to sense and optimize the world around us with reference to a global world model," which would "inform us about the energy consumption and other effects of our activities on the natural environment."

The third goal is a new emphasis on predicting and responding to future events by modeling their behavior. According to Hopper and Rice, "The traditional role of computing as an execution platform for these models will continue to be important and must grow in performance to service both the increasing demands of higher-fidelity models and also to accommodate any new overheads incurred by correctness checking."

Lastly, Hopper and Rice are "interested in the possible benefit of digital alternatives to our physical activities," such as electronic versions of printed newspapers, music downloads rather than physical CDs, and online shopping as opposed to visiting stores and supermarkets. According to Hopper and Rice, "One might argue that a total shift from physical to digital seems unlikely in today's world but for future generations this concept might seem as obvious as email is to us today."

"People in the developing world," Hopper and Rice note, "often live in resource-impoverished environments so a physical-to-digital paradigm shift has the potential to enable activities that were hitherto prohibitively expensive, and to support development whilst minimizing its impact. We seek to unlock methods of wealth creation in the virtual world."

Hopper and Rice also suggest the development of a personal energy meter that would measure a person's direct and indirect daily consumption, with individualized breakdowns of "the energy costs of travel, heating, water-usage and transportation of food [that] will help us target areas for reduction in our environmental footprint.... The data collected will not only provide useful information for analyzing consumption patterns but also has the potential to help individuals identify alternatives to their current activities."

"I think we've only just started to address the issue" of green computing, says Hopper. "It's just on the cusp of becoming important, and I think business, not academia, has led the way. They are driven by pragmatic concerns." C

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Artificial Intelligence

Supercomputer Defeats Human Go Pro

The new Dutch supercomputer Huygens, armed with the MoGo Titan program, defeated a human professional Go player with a 9-stones handicap. The victory appears to be the first-ever defeat of a high-level human Go player by a supercomputer in an official match.

Until recently, scientists were unable to create a computer program capable of beating even many amateur-level Go players. This state of affairs changed in 2006 when programmers Sylvain Gelly and Yizao Wang devised a revolutionary algorithm that has enabled the MoGo Titan program to attain new heights; since August 2006, MoGo Titan has been ranked number one on the 9x9 Computer Go Server.

Teamed up with the Huygens supercomputer, MoGo Titan achieved a noteworthy victory as its opponent, Kim Myungwan, is an 8 dan pro (the highest level is 9 dan) and a seasoned international competitor. In fact, the day before Myungwan's official match with Huygens and MoGo Titan, he soundly defeated the duo in three blitz games played with varying handicaps.

"The current result forecasts that before 2020 a computer program will defeat the best human Go player on a 19x19 Go board in a regular match under normal tournament conditions," says professor Jaap van den Herik of Maastricht University which, with INRIA France, co-developed MoGo Titan. "This is remarkable, since around 2000 it was generally believed that the game of Go was safe to any attack by a computer program. The 9-stones handicap victory casts severe doubts on this belief."

The Korean-born Myungwan appears to have taken the defeat well. Two days after his loss to MoGo Titan, he won the 2008 U.S. Open.