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Is it easy being green?

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THERE REMAINS SOME CONFUSION about whether the term "Green Information Technology" refers to "being Green" or "saving Green ($)," and seeking convergence between the two often conflicting meanings is critical to developing a sustainable IT infrastructure.

Is it easy being Green? Unlike Kermit the frog, IT managers have a choice, and face difficult decisions between Green and not-so-Green approaches to IT. The dividing line between Green and not-so-Green is less clearly defined than it might seem at first glance. Considering the whole IT life cycle—or even the whole business life cycle that IT supports—can uncover subtle misconceptions that change what "being Green" entails.

What Is Green IT?

As with most terms forged mostly by marketing efforts, it is difficult to precisely define what is meant by "Green Information Technology" (Green IT). Considering the common threads from all vendor-supplied definitions, it seems to mean "considering the environment and environmental impact" in designing, building, managing, and decommissioning IT systems. This includes considering the impact of:

1. Power utilization, including the impact of power generation
2. Heat management, including heat release to the environment, as well as power requirements for moving heat around
3. Processes for manufacturing and disposal of computing hardware

Oddly enough, although there are plenty of available commercial approaches for "Greening" (1) and (2), there are few alternatives for coping with (3), although it remains part of the popular definition of "Green IT."

The root of this quandary is that there are two kinds of Green: the Green that refers to protecting the environment, and the Green that represents money kept in one's wallet. In addressing (1) and (2) above, one can often pursue the two kinds of Green at the same time, while addressing (3) requires that one kind of Green take precedence over the other. The former is easily sold to businesses, while the latter is an extremely hard sell.

For example, saving power in running an IT infrastructure is Green in two ways, because one both

saves environmental impact (from power generation) and saves money (because power is a tangible cost of IT). Seemingly extreme changes such as putting up one's own solar panels or windmills can have a relatively short payback period and are undoubtedly Green in both ways (but there are some subtleties of life cycle analysis that most might easily miss, mentioned below).

On the Ground or in the Clouds?

The popular concept of Green IT is part of the motivation for many current research and development efforts.

Power awareness is one of the main practical outgrowths of autonomic computing, in the sense that many practical algorithms exist for minimizing power and cooling requirements while still responding to predicted loads. Some researchers think power awareness will be the main selling point for autonomic systems in the future, because it is one of the key business goals that a human administrator cannot feasibly attain.

While one can achieve power awareness even at small scales, it is one of the few aspects of computing that becomes more feasible and practical as scale increases. Power awareness can be achieved particularly well in cloud computing, in which one farm of servers serves multiple applications. One important side benefit of cloud computing is that one can cluster applications inside clouds and "optimize the ensemble" to save power [1]. Because a cloud serves multiple applications, it can reduce power needs by maintaining a capacity pool for all clients, not for each client separately.

Conflict Between the Greens

However, some aspects of Green IT—that are only Green in a single way—are much harder sells. Consider, e.g., how machine rooms are cooled. It is much cheaper (the monetary kind of Green) to cool the rooms with running groundwater, e.g., rivers, rather than using power and air-conditioning to release heat into the air, but this is considered to be very bad for the other kind of Green, because it affects and can radically transform the habitat for aquatic life. The practice of using natural cooling of this kind remains a highly controversial and emotional issue, perhaps because we know something of the potential impact from our use of groundwater to cool nuclear power plants [2].

The conflict between the two kinds of Green is perhaps most extreme when one considers equipment life cycles. An environmentally aware IT management strategy must also consider not only the impact of utilizing hardware, but also of manufacturing and disposing of hardware. Computer manufacturing continues to generate many hazardous wastes, with no easy solutions in sight. Disposal and recycling of computing equipment are also a growing problem, with the average computer obsoleted and replaced every three years or less.

Part of what makes managing equipment life cycles difficult is that the money to be made by planned obsolescence (even including upgrading to more power-efficient hardware) trumps the environmental impact of disposing of the so-called "obsolete" equipment. Here it seems that a viable Green alternative would have to reduce disposal impact while at the same time encouraging innovation and growth. Convergence between the two kinds of Green in this case would likely involve implementing a completely new and innovative business model for upgrading computing equipment, much like

the maintenance agreements we currently buy for software. We would hang on to our computers longer if we could safely upgrade their capabilities, but one can be sure that for financial viability, such upgradable units would come with a relatively high price tag compared to that of today's "disposable" hardware.

Life Cycle Analysis

Considering equipment recycling in Green IT is an example of "life cycle analysis," which entails taking a broad view of the whole process of providing a service and taking into account the impact of every step from service inception to service decommissioning. The practice of life cycle analysis has disciplinary roots in chemical and process engineering, but can just as easily be applied to IT.

Taking the broad view of power has already led to some counterintuitive surprises with analogues in IT. In calculating the emissions of coal-burning power plants, accounting for emissions arising from moving the coal via truck or train—as well as the emissions from the power plant—demonstrates that burning locally available coal that burns less cleanly leads to lower total emissions than trucking in cleaner-burning coal from remote locations [3]. In the same way, the location of a data center affects the total power consumption of the enterprise in distributing data and serving computational needs.

Even taking seemingly positive steps can have hidden impacts. Mandating use of fluorescent bulbs to save energy leads to a secondary disposal problem for the mercury in the bulbs, in the same way that replacing all computer hardware with lower-power alternatives leads to a recycling problem for the higher-power obsolete hardware. And the apparently "Green" strategy of putting up solar panels may not look as Green when one considers the life cycle of the panels, their mean time to failure, and their manufacturing and recycling impacts. Solar cells are not created equal, so the lowest-impact solar power requires some careful planning and choices. Still, solar is much cleaner overall than burning fossil fuels, and most of the environmental impact from solar cells is from burning fossil fuels during the manufacturing process [4]. In considering the broad view, solar-powered boilers whose steam output is converted to electricity in the usual way are considered to be "less efficient" in producing power than solar cells, but may have even less environmental impact than solar cells when their impact is averaged over the life cycle of the equipment.

Thus, one might ask, if taking the broad view has such profound impact upon one's decisions, why is "Green IT" focusing only upon the data center? What different decisions would we make if we considered instead the life cycle of the entire business process? This question is at the root of some criticisms of the current concept of "Green IT."

"Green" Versus "Sustainable"

Lack of progress in Green directions—and seemingly limited opportunities for financially sensible Green—have given the term "Green IT" a bad name in some circles. It has become synonymous with talking about considering the environment while unapologetically continuing business practices that actively harm it. "Green IT" seems to be about compartmentalizing the environmental impact problem in the data center, "fixing the data center," and leaving the rest of the business process intact, wasteful, and blind to environmental concerns. The compartmentalization of "Green" extends even

into the IT research community, which is for the most part studying "power awareness" (and strategies that save money) instead of a broader concept of "environmental awareness" (and strategies that cost money).

Some would prefer that we instead pursue a more aggressive goal of "Sustainable IT." While "Green IT" has come to mean "best effort" environmental awareness, "Sustainable IT" refers to running the data center with as little environmental impact as possible.

Even with "Sustainable IT," sustainability is still compartmentalized in the datacenter and cannot touch parts of business process that are consumers of IT. One is limited to making relatively small improvements in what is considered the purview of IT departments.

The lessons of life cycle analysis suggest that "Sustainable IT" is too narrow and that one should instead consider the sum total of all environmental impacts in all business decisions and target for a "Sustainable Enterprise," aiming for zero total impact for the whole enterprise.

For example, one major improvement in the business process would be to replace travel with telecommuting and virtual meetings. This is a business process change that is "Green" in both ways: it reduces corporate environmental impact and saves money by reducing consumption of fossil fuels during travel to and from meetings.

Green Versus Inertia

One often finds that a fantastic idea that would transform the way the world does business cannot be implemented, because the world is much too satisfied with the way it currently does business. The stark reality is that changes in business process can be incredibly expensive, involving retraining staff for new policies, as well as developing and managing new concepts of customer expectation. The true opponents of sustainability are inertia and the cost of changing how businesses are run and how business decisions are made. Truly sustainable infrastructure may well require a transformation of society, not just a transformation of technology, in very much the same way that our dependence upon oil can only be removed by a rather large shift in the way we live.

So true convergence between the two kinds of Green may be impossible, but that does not mean we can't redefine the two kinds in subtle ways to make convergence more likely. This is the true challenge and promise of sustainable computing.

The USENIX Board of Directors asked me, in my role as the Secretary of the Board, to look into the prospects for Green IT and explore what USENIX can contribute to the effort. I am open to input from everyone on this issue; please feel free to contact me at my email address, alva@usenix.org.

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