EnergIT: A Methodology for the Incremental Green Design of Data Centers

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ABSTRACT

Researches on green data centers have defined guidelines and end-to-end methodologies to increase energy efficiency. Most of these approaches require a disrupting reengineering of the infrastructure and significant upfront investments. Smaller data centers need to reach green objectives with a more incremental approach. The EnergIT project proposes a methodology and related tools that support the incremental redesign of data centers toward greater energy efficiency based on three main levers: 1) physical repositioning of servers to optimize air flow circulation and cooling, enabling higher set temperatures of the cooling system; 2) replacement of server models; and 3) virtualization. This paper describes the approach and provides evidence on the effectiveness of the methodology by showing how the combined effect of the three levers has led to 62% reduction of energy consumption in a real case study.

Keywords: Cooling Optimization, Data Center Energy Efficiency, Green Data Centers, Server Models, Virtualization

INTRODUCTION

Research on Green ICT has been active for over a decade and is currently structured as a multidisciplinary research area offering consolidated end-to-end methodologies (cf. Schultz, 2009; Patel et al., 2002; Bash & Foreman, 2007; Shah et al., 2008; Brown & Reams, 2010) and numerous in-depth systematic studies (cf. Li et al., 2007; Patel et al., 2002). Within the Green ICT area, the green data center research stream is particularly active, with a correspondingly
broad array of market solutions. Hardware vendors have included energy efficiency among their base set of target parameters, and are constantly benchmarked against their performance-to-power ratio (cf. www.spec.org/power_ssj2008). Most governments have embedded these benchmarks in their green procurement guidelines, and the EU has issued the EU data center code of conduct which has been endorsed by several US companies and trade associations (cf. http://re.jrc.ec.europa.eu). These guidelines refer to best practices on both IT equipment and facilities, including cooling systems, air conditioning units, UPSs and PDUs. Overall, under the clean slate assumption, a company could design, build, and operate a new data center according to convincing and trusted green practices.

Unfortunately, most companies cannot afford a disruptive reengineering of their infrastructure, which would require renovated buildings, top market hardware, new racks, and modern cooling equipment. For example, medium-size ISPs which typically offer hosting and housing services must efficiently manage their customers’ hardware without necessarily replacing it. Due to their financial and service constraints, smaller data centers need to reach green objectives with a more incremental approach. This goal raises the following questions: What can companies do to improve the energy efficiency of their data centers without embarking on large-scale reengineering projects? How can they draw an incremental change path towards energy efficiency that allows them to start from the most beneficial and lowest cost changes?

These questions are largely unanswered in the literature. The EnergIT project has started from the results of a pilot survey among small- and medium-size data centers operating in the Lombardy Region in Italy. These organizations clearly stated their concern with mainstream green methodologies and technologies, pointing to a lack of objective studies measuring the payoffs of green investments that helped them to choose and enact the most convenient green actions along an incremental reengineering path. In particular, they highlighted a need for measuring the benefits of top-market solutions against the most energy efficient scenario that can be reached by implementing incremental actions based on the lower-end market. In this respect, vendors’ benchmarks of green payoffs were not judged entirely helpful, since they typically compare the top-market with the current situation, which they equated with the worst case scenario.

For example, it is well known how a rationalization of data centers based on consolidation and virtualization can reduce CPU requirements up to an order of magnitude, with energy benefits as a side effect (cf. Liu et al., 2009; www.vmware.com). Whether accounting for these benefits when assessing the payoffs of green is questionable. Large green projects are often justified on the basis of all possible economic returns, including the cost reductions from virtualization. However, part of these benefits can be obtained by applying virtualization to legacy servers without investing in new expensive green hardware, such as high-performance blade servers and enclosures or dedicated precision cooling infrastructures. In this case, addressing small data centers needs means assessing the gap between these benefits and the maximum possible returns involving investments in the newest and most efficient hardware.

Cloud computing is an emerging phenomenon that could have a deep impact on energy efficiency (Berl et al., 2009). Centralizing computing capacity into large data center and leveraging virtualization may offer scale efficiency even to smaller organizations. However, going cloud is an organizational choice that presents several issues, including loss of control, privacy, dependence from network connection and from providers. For these reasons small and medium-size data centers are likely to stay in operations for years. However, it is likely that significant money investments will be reserved to larger data centers.

The EnergIT project takes the perspective of small- and medium-size data centers. The overall goal of the project is to provide a methodology and related tools that support the incremental redesign of data centers towards greater energy efficiency. From a methodologi-
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