THE SERVICE GREENERY - INTEGRATING SUSTAINABILITY IN SERVICE ORIENTED SOFTWARE

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ABSTRACT

Carbon emission of IT is an issue. ICT energy consumption is expected to grow by 73% (instead of the originally targeted 26%) until 2020, and the service sector alone counts for 70% of the European economy. Energy consumption is a combination of *what* we use, and *how* we use it. Most green initiatives look at *what* types of devices do consume energy, and try to optimize their up-time as such. Few initiatives, though, measure *how* do software systems actually use these devices, with the goal of optimize consumption of devices and computing resources. Basic research is needed to address this software optimization problem. The proposed approach is to make visible the environmental impact of software services by measuring it. In this way, we will become aware of the amount of energy needed by our software, and hence target software optimization where mostly needed. In this paper we present our approach to service-based applications, and identify open research directions.

Index Terms— green IT, service orientation, green metrics, sustainability

1. INTRODUCTION

In the last decade, Service Orientation (SO) and Service-Oriented Computing have emerged as a major software development discipline resembling (if not outbalancing) what object orientation meant for the IT market of the eighties. Service Oriented Architecture (SOA) captures a logical way of providing software services both within an enterprise, and across organizational and national boundaries to either end-user applications or other services distributed on a network [3]. A well-constructed SOA can empower a business or social environment with a flexible infrastructure and processing environment by providing independent, reusable automated business processes (as services), and a robust foundation for leveraging these services [2, 5].

Due to its fast application in all aspects of our society, Service Orientation should address environmental issues promptly: in this period of acceptation and learning, we should think about how to sensitize people to the adoption of an ecological approach to the construction, deployment and use of service-based applications (SBAs). Unfortunately, service-oriented software is often developed assuming availability of unlimited resources: 24x7 service availability, unlimited use of computing power, hardware, network and printing resources (all demanding energy and often causing carbon emission). The increase in the network traffic and in the number of electronic data centers is having a huge impact on the environment (an average data center is consuming the same amount of energy as about 26,000 households). Almost 90% of young Americans are “always connected”. This also impacts energy consumption, e.g., in the Netherlands, total electricity consumption increased between 2006 and 2008 by 12%. Without focussed environmental strategies, ICT related energy consumption is expected to grow by 73% until 2020 (instead of the targeted 26%).

IT systems and data centers are migrating towards a service oriented approach in which the available computing resources are shared by several types of users and organizations. In such systems, the software is accessed as-a-service and computational capacity is offered on demand to customers who share a pool of IT resources in-the-cloud [4]. The software as-a-service (SaaS) model provides significant economies of scale, affecting the energy efficiency of data centers [1].

Environmental strategies are already a reality in non-IT domains. For instance, Sweden recently introduced on many supermarket products an indication of the Carbon emission related to their production process, to change alimentary habits toward more environmental friendly products, similar to what already happens for choosing cars and house-hold equipment. As another example in the more traditional hardware/embedded software domain, some companies already commercialize devices that are plugged in the electricity socket and allow users to monitor and gain detailed understanding of their energy consumption.

Adoption is much more difficult in intangible domains like the software industry for at least two reasons. First, it is a challenge to increase *people awareness*, i.e. convince decision makers of the urgency of adopting ecological strategies in their IT portfolios and bring IT practitioners to adopt innovative ecological models in the way they engineer SBAs. In addition, we urgently need to change the way users exploit SaaS, by making them realize their energy consumption and suggest alternative consumption models.

Second, it is difficult to make explicit how SBAs should be engineered to become "greener", i.e. to define and implement how ecological strategies can be adopted by service-oriented software (*service awareness*). Awareness can be increased with a SaaS model, by offering "green metrics" to measure the level of greenness of software services, and incorporate in SBAs ready-to-use "feedback services", i.e. services that give feedback on the carbon footprint of SBAs and of their end-users.

2. THE SERVICE GREENERY APPROACH

To increase both people and service awareness, we plan to create what we call a *service greenery*, i.e. a portfolio of green services accessible on the Web as-a-service. The service greenery supports the iterative, incremental approach to increasing sustainability, as illustrated in Fig. 1. This is centered around two types of services (central part in the Figure):

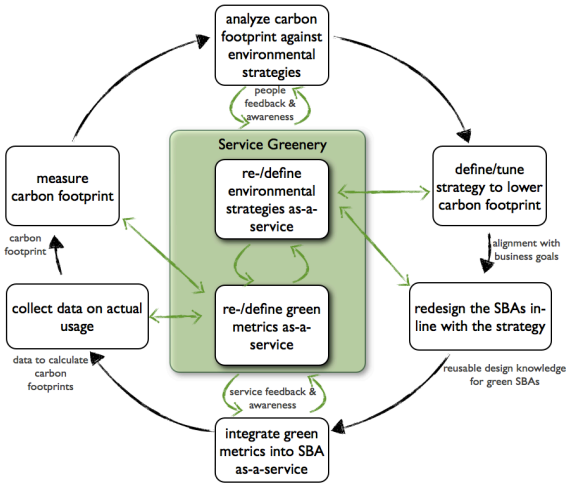

Fig. 1 - Central role of the Service Greenery to redesign environmental-aware SBAs

- **Environmental strategies as-a-service**, which set out the user's/organization's goals and actions for achieving a sustainable environment. Examples of generic organizational strategies are 'achieve tighter customer relationships' or 'become more standard'. Equivalent green strategies could be 'achieve carbon neutral data traffic' or 'decrease the company's global carbon footprint by x% before year y'. Such strategies will be defined in terms of the user's/organization's business processes. Accordingly, users/organizations can use environmental strategies as instrument for lowering carbon footprint, and at the same time keep them aligned with the supporting IT services/SBAs.
- **Green metrics as-a-service**, which measure the actual carbon footprint of SBAs. In this way, the user/ organization can monitor realtime the SBA environmental impact and provide feedback to end-users and companies. This will increase people awareness (by leading users to opt for options consuming less energy) as well as service awareness (by quantifying the current carbon footprint).

The **service greenery** will make available environmental strategies as-a-service and their supporting green metrics as-a-service. It will trigger use and reuse of the green metrics, create incentives to tailor strategies and measures to business goals, hence re-populating the service greenery with new resources. The ultimate goal is to make service-oriented software "greener" by initiating the adoption of environmental strategies offered as-a-service, continuously measuring the achieved level of greenness, and tune the strategies to increase it.

3. RESEARCH DIRECTIONS

What do we need to realize our service greenery? Here we list some necessary ingredients for further research:

- A set of **environmental strategies** leveraging best practices for translating green business strategies into green SBAs, measuring their ecological impact, raising people awareness.
- A set of **green metrics**, to measure the level of greenness of SBAs, and the impact of design decisions on energy consumption.
- Innovative **green knowledge** like green design models and green best practices. If this knowledge is available we will be able to change the mindset of software developers, so that they will be aware of the need for green software as well as ways to develop it.

No need to say that by making the ingredients above available as reusable assets we can identify innovative ways to greenify the industry IT portfolio; we can increase people- and service awareness thanks to continuous measurement & feedback; we can disseminate reusable green knowledge offered to researchers and practitioners.

10. REFERENCES

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