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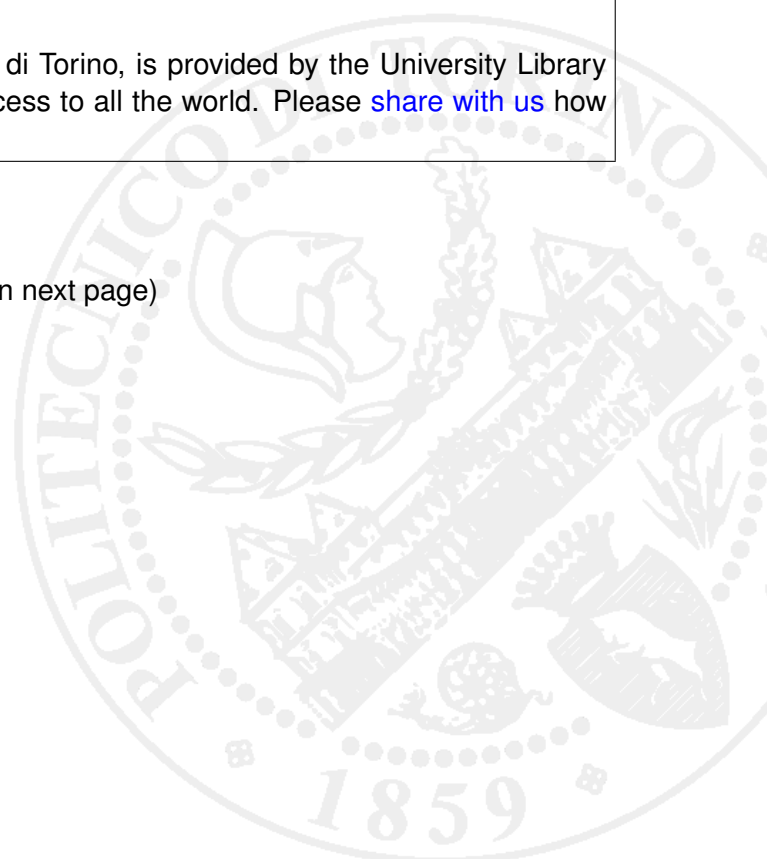
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4th International Workshop on Green and Sustainable Software (GREENS 2015)

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Abstract—Engineering green software-intensive systems is critical in our drive towards a sustainable, smarter planet. The goal of green software engineering is to apply green principles to the design and operation of software-intensive systems. Green and self-greening software systems have tremendous potential to decrease energy consumption. Moreover, enterprise software can and should be re-thought to address sustainability issues using innovative business models, processes, and incentives. Monitoring and measuring the greenness of software is critical towards the notion of sustainable and green software. Demonstrating improvement is paramount for users to achieve and affect change. Thus, the theme of GREENS 2015 is *Towards a Green Software Body of Knowledge*. The GREENS workshop series brings together researchers and practitioners to discuss both the state-of-the-art and state-of-the-practice in green software, including novel ideas, research challenges, methods, experiences, and tools to support the engineering of sustainable and energy efficient software systems. **Index terms:** Green software engineering, green design, key green indicators (KGIs), green monitoring, green adaptation, smart green sensors and actuators, self-greening, energy efficiency, sustainability, green scheduling, green computing, green IT.

I. INTRODUCTION

Software can contribute to decrease power consumption—become greener—by being more *energy efficient*—using fewer resources; or by making its supported processes *more sustainable*—decreasing the environmental impact of governments, companies, and individuals using software applications and services. While research results exist in measuring and controlling the level of greenness of hardware components, major research is needed to relate energy consumption of hardware to energy consumption of its executing software. With the proliferation of smart devices, the Internet of Things, the Industrial Internet and the Internet of Everything, the world is increasingly being instrumented with sensors and thus we have a better chance to quantify energy consumption due to the software execution.

Providing effective, proven guidelines to build green software is of paramount importance both to disseminate and adopt green practices in industry and to focus the work of researchers.

II. WORKSHOP THEME AND GOALS

While we readily accept that software is embedded in all aspects of modern society, we lack sound instruments to develop them to be greener. Currently software architects and software system operators cannot reliably make green decisions because there is little experience with green business strategies and green software engineering methods to design, implement, and run greener software-intensive systems. Such strategies and methods ought to motivate and adapt to the user’s behavior as well as induce desired outcomes. In summary, this workshop aims to provide a forum for researchers and practitioners to guide software engineering research in this critical area towards a smarter planet.

The theme of this fourth edition of GREENS is “Towards a Green Software body of knowledge.” Developers need to have clear guidelines on building green software. Researchers need to organize the green knowledge, for knowledge translation as well as identifying gaps for further research. The Green software body of knowledge is the means to achieve both goals and link practitioners and researchers better.

GREENS 2015 encourages contributions from industry, government, and academia on all topics related to greener software engineering. Topics include, but are not limited to:

- Requirements engineering, architecting and design methods for green software
- Best practices to increase energy efficiency and sustainability (including software and process improvement)
- Instrument and monitor software systems to key green indicators (KGIs) and green improvement

- Smart green sensors, actuators and networks
- Energy-aware adaptation of software-intensive systems
- Self-adaptive and self-managing systems for green computing
- Green architectural knowledge, green design patterns
- Sustainable data management
- Monitoring, verification and validation of green software
- Creating user awareness about energy consumption of software applications and services
- Tools to support green decision making, tools to visualize green data
- Green key performance indicators
- Quality & risk assessments, tradeoff analyses between energy efficiency, sustainability and traditional quality requirements
- Business models for green software (e.g., SaaS, IaaS, PaaS, and cloud computing)
- Formulating challenges for a green software industry
- Return on investments and economic aspects of green software development
- Case studies and industry experience reports
- Incentives to invest in greener software

III. WORKSHOP ORGANIZERS

Maurizio Morisio is a professor of computer science at Politecnico di Torino, Italy. He works in the area of Software Engineering, and notably software reuse, service engineering, mobile software engineering. Since 1995 he has applied empirical methods, such as case studies, experiments, surveys, to prove or disprove the effectiveness of a technique, tool or method starting from observation of facts instead of claims. He has managed research projects for more than 1.5 MEuros. His main professional activities are: IEEE Software, Associate editor in chief, Empirical Software Engineering Journal, Associate editor. He was program co-chair of the 13th International Conference on Software Reuse, and General Chair of ESEIW (Empirical Software Engineering International Week) 2014.

Patricia Lago is an associate professor at the VU University Amsterdam, leading the group on software- and service engineering. Her research interests focus on software- and service architectures, architectural knowledge management and green IT. She is member of the IFIP 2.10 WG on Software Architecture, the IFIP 2.14 WG on Services-based Systems, and core member of the Dutch Knowledge Network on Green

Software. She has been local chair of ESEC/FSE 2009, program co-chair of IEEE/IFIP WICSA 2011 and 2015, ICT4S 2014, and since 2009 PC co-chair of the Dutch Software Architecture Conference (700 attendees mostly from industry). She co-organized various workshops and events in fields relevant to this proposal, including GREENS, PESOS and SHARK workshop series. She is co-organizer of the SEIS track at ICSE 2015.

Niklaus Meyer is president of the Green IT SIG of the Swiss Informatics Society, consisting of about 2000 IT professionals from industry and academia. Green IT SIG is the forum to discuss how ICT execution can be more ecological, economical and social as well as how software applications can contribute to greening business, Industry and the society at large. Until 2009 he was Group Vice President of the Research Board, a 40 year-old membership organisation of Chief Information Officers (CIO) from the world's largest corporations and a subsidiary of Gartner. Before that he was CIO and Head of Corporate IT of multi-national Zurich Insurance Group.

Hausi A. Müller serves on the IEEE Computer Society Board of Governors and is Chair of the IEEE CS Technical Council on Software Engineering (TCSE). His research interests include software evolution, self-adaptive systems, context-aware systems, green computing, and future digital ecosystems. He was General Chair of ICSME 2014 in Victoria, SEAMS 2012 in Zürich and SEAMS 2009 in Vancouver. He was Co-Chair of the Software Engineering Education Track of ICSE 2012. He was Program Co-Chair of CASCON 2010. He was Co-Organizer of the Shonan Meetings on Engineering Adaptive Software Systems (EASSy 2015, EASSy 2013) and 2010 Dagstuhl Seminar on Software Engineering for Self-Adaptive Systems. He was General Chair of ICSE 2001 in Toronto.

Giuseppe Scanniello is an assistant professor at the University of Basilicata, where he leads the Software Engineering Group. His research interests are in the area of software engineering and include global software development, software maintenance, program comprehension, empirical studies in software engineering, cooperative systems for software engineering, version and configuration management, and visual languages. He serves in the program and organizing committees of international workshops, summer school, and conferences. He has published more than 130 papers on these topics in international journals, books, and conference and workshop proceedings. He is a member of the IEEE Computer Society.