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"Why Humans Can't *Green* Computers" An Autonomous Green Approach for Distributed Environments

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Energy-aware solutions and approaches are becoming broadly available as energy concerns is becoming mainstream. The usage of computers and other electronic devices (*e.g.*, smartphones, sensors, or digital equipments) is increasing, thus impacting the overall energy consumption. Although ICT accounts for 2% of global carbon emissions in 2007 [4], ICT solutions could help in reducing the energy footprint of other sectors (*e.g.*, building, transportation, industry). In [10], the Climate Group estimates that ICT solutions could reduce 15% of carbon emissions in 2020. However, in 2007, ICT footprint was 830 $MtCO_2e$ and is expected to grow to 1,430 $MtCO_2e$ in 2020 [10]. These numbers show the need for efficient ICT solutions in order to reduce carbon emissions and energy consumption.

Reducing the energy consumption of connected devices and computers requires a comprehensive view of the different layers of the system. Sensors and actuators, used to monitor energy consumption and modify devices' options, need to be controlled by intelligent software. Applications running on the devices and the hardware itself also need to be monitored and controlled in order to achieve efficient energy savings. The middleware layer positions itself as a relevant candidate for hosting energy-aware approaches and solutions.

Many approaches have been proposed to manage the energy consumption of the hardware, operating system, or software layers. In particular, more and more architectural or algorithmic solutions are now emerging in the middleware layer. The widespread usage of mobile devices and the high coverage of networks (WiFi, 3G) have led to a new generation of communicating and moving devices. Therefore, the middleware layer requires a flexible approach to manage efficiently the energy consumption of such devices at a large-scale level.

Many middleware platforms, architectures, optimization techniques or algorithms already exist for energy management of hardware or software. Rule-based approaches offer a high degree of architectural autonomy, but with a limited decisional autonomy. The architecture of the middleware is flexible and evolutive, and can easily cope with changes in the environment. Rules, on the other hand, need to be predefined and updated on environment's evolutions. Current rule-based solutions ([3, 5, 11]) use predefined and manually updated rules and policies.

Predefined approaches vary from algorithmic adaptations ([1, 6]), to protocol ones [8], to modeling ones [12]. The approach in [7, 9] uses predefined allocation and prediction

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[⋆] Ph.D. student under the supervision of Prof. Lionel Seinturier and Dr. Romain Rouvoy algorithms and predefined coordination. The approach in [2] takes a wider approach with adapting itself to the user habits and the environments events. This context-based event learning offers better autonomic management than other approaches.

Although these approaches offer a certain degree of autonomic management of energy consumption, a full autonomous energy management is yet to be defined. An energy-aware autonomous approach should therefore imitate the human body metabolism: the platform needs to be transparent to the user and to devices and applications, but without limiting users' high-level decisions. In the human body, when energy becomes low, the system starts by using its reserves and notifying the human about the situation (*e.g.*, the human feels hunger). Therefore, the human could apply high-level decisions, such as eating (to recharge his energy and reserves), or reduce his activity, or go to sleep (low power mode). We therefore believe that middleware approaches should take inspiration from biologic systems and provide a similar autonomous functioning for energy-awareness because the complexity of systems is rapidly increasing.

We propose an approach that adapts the software components and hardware parameters in an autonomous manner. User interaction is therefore limited to defining some of the user preferences and very high-level energy-aware policies (through an energy-aware DSL). We also propose to use distributed services (locally and on the cloud) in order to provide flexibility and evolution to the architecture. The local services will store energy information, but also usage patterns and user preferences. Remote servers on the cloud will take the role of a worldwide knowledge repository. They will also be used for utility services (*e.g.*, electricity price), user activity synchronization (*e.g.*, the user's online agenda), and computation and intelligence offloading. A modular monitoring environment is reponsible for collecting energy-aware information from the environment. The degree of the collected information can vary from fine-grained information (*e.g.*, per class or per method in an application) or coarse-grained (*e.g.*, per process or per device). Preliminary results on our monitoring environment provide fine-grained information on the energy consumption of classes and methods inside a Java application. We are currently working on extending and experimenting the monitoring environment in order to optimize its overhead and integrate it into our architecture.

References

[1] Binder, W., Suri, N.: Green Computing: Energy Consumption Optimized Service Hosting. In: Proceedings of the 35th Conference on Current Trends in Theory and Practice of Computer Science (SOFSEM '09). pp. 117–128. Springer-Verlag, Berlin, Heidelberg (2009)

[2] Capone, A., Barros, M., Hrasnica, H., Tompros, S.: A new architecture for reduction of energy consumption of home appliances. In: Towards eEnvironment, European conference of the Czech Presidency of the Council of the EU (e-Envi'2009). Prague, Czech Republic (2009)

[3] Demeure, I., Paroux, G., Hernando-ureta, J., Khakpour, A.R., Nowalczyk, J.: An energy-aware middleware for collaboration on small scale manets. In: Proceedings of the Autonomous and Spontaneous Networks Symposium (ASN'08). Paris, France (November 2008)

[4] Gartner: Green it: The new industry shockwave. Presentation at Symposium/ITXPO Conference (2007)

[5] Klein, A., Jerzak, Z.: Ginseng for sustainable energy awareness: flexible energy monitoring using wireless sensor nodes. In: Proceedings of the 4th ACM International Conference on Distributed Event-Based Systems (DEBS '10). pp. 109–110. ACM, New York, NY, USA (2010), `http://doi.acm.org/10.1145/1827418.1827443`

[6] Mohapatra, S., Venkatasubramanian, N.: Parm: Power aware reconfigurable middleware. In: Proceedings of the 23rd International Conference on Distributed Computing Systems (ICDCS'03). p. 312. IEEE Computer Society, Washington, DC, USA (2003)

[7] Sachs, D.G., Yuan, W., Hughes, C.J., Harris, A., Adve, S.V., Jones, D.L., Kravets, R.H., Nahrstedt, K.: Grace: A hierarchical adaptation framework for saving energy (2004)

[8] Schiele, G., Handte, M., Becker, C.: Experiences in designing an energy-aware middleware for pervasive computing. In: Proceedings of the 6th Annual IEEE International Conference on Pervasive Computing and Communications (PERCOM'08). pp. 504–508. IEEE Computer Society, Washington, DC, USA (2008), `http://portal.acm.org/citation.cfm?id=1371610.1372873`

[9] Vardhan, V., Yuan, W., III, A.F.H., Adve, S.V., Kravets, R., Nahrstedt, K., Sachs, D.G., Jones, D.L.: Grace-2: integrating fine-grained application adaptation with global adaptation for saving energy. International Journal of Engineering Science 4(2), 152–169 (2009)

[10] Webb, M.: SMART 2020: enabling the low carbon economy in the information age, a report by The Climate Group on behalf of the Global eSustainability Initiative (GeSI) (2008)

[11] Xiao, Y., Kalyanaraman, R.S., Ylä-Jääski, A.: Middleware for energy-awareness in mobile devices. In: Proceedings of the 4th International ICST Conference on Communication System software and middleware (COMSWARE'09). pp. 1–6. ACM, New York, NY, USA (2009)

[12] Zeng, H., Ellis, C.S., Lebeck, A.R.: Experiences in managing energy with ecosystem. IEEE Pervasive Computing 4, 62–68 (January 2005), `http://dx.doi.org/10.1109/MPRV.2005.10`