Fabien Hermenier

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Activities

- **Sep. 2011 - : Associate Professor** *University of Nice Sophia Antipolis*

- **Mar. 2011 - Sep. 2011 : Post-doctoral researcher** *University of Salt Lake City, Flux research group*

- **Oct. 2009 - Sep. 2010 : Post-doctoral researcher** *École des Mines de Nantes, ASCOLA Research group*

- **2006 - 2009 : PhD. in Computer Science (manuscript in French)**
  Defended in november, the 26th 2009
  University of Nantes, France – École des Mines de Nantes – LINA, UMR CNRS 6241

  - Title : *Gestion dynamique des tâches dans les grappes, une approche à base de machines virtuelles*
    (English title: *Online Management of Jobs in Clusters using Virtual Machines*)
  - Advisors : Gilles Muller (Professor, INRIA Rocquencourt), Jean-Marc Menaud (Associate Professor, École des Mines de Nantes)
  - Research Lab: ASCOLA group

- **2005 - 2006 : Mres in "Distributed Softwares Architectures" (manuscript in French)**
  University of Nantes, France – OBASCO group – LINA, UMR CNRS 6241

  - Title : *Gestion dynamique des grilles informatiques, applications à l'économie d'énergie*
    English title : *Dynamic Management of Grids applied to power saving*
  - Advisors : Jean-Marc Menaud (Associate Professor, 'Ecole des Mines de Nantes)

- **2003 - 2005 : Bachelor Degree in "Mathematics and Computer Science: Systems and Networks"**
  University of South Britanny – Vannes, France

Awards

- **2009: Prix de la croissance verte numerique**
  The French Business Confederation rewarded the development of ITs focused on sustainable development. I received a prize with Jean-Marc Menaud for the development of the prototype *Entropy*, I have developed during my Phd. Details about the prize and our video interview are available online:
  http://entropy.gforge.inria.fr/croissanceverte.html

- **2009: Best thesis of the University of Nantes**
  Doctoral schools reward three thesis that are considered as the best with regards to their associated publications and valuations. 20 thesis were proposed by different research labs.

Research Topics

I am interested in resource management inside hosting platforms. This covers of course modeling, implementing and evaluating objective specific schedulers but also defining user friendly and robust solutions that are easy to use and to extend by non-expert users.

PhD. Thesis topic

Cluster computing is an attractive solution to meet the growing computational requirements of scientific applications. In this setting, a user organizes a job as a collection of tasks that each requires a finite amount of resources for a bounded amount of time. A scheduling algorithm is responsible of selecting the jobs to execute on the cluster by finding, for each task composing the jobs, a node with a sufficient amount of free resources. Static scheduling algorithms allocate each task to a node and a constant amount of resources for all the duration of the job. Such strategies lead to a waste of resources and a non-optimal schedule of the jobs as each task does not use all of the allocated resources at all times. On the opposite, dynamic scheduling algorithms manipulate in live the state of the jobs using preemption and the location of their tasks using process migration. These algorithms provide a finer use of resources by allocating them according to the current demand instead of the users estimate. In practice, dynamic scheduling strategies are hard to deploy on clusters. First, the actions that manipulate the tasks in live are tedious to implement in a non-intrusive way. Second, their executions are time and resource consuming and misusing them lead to a high computational overhead. Finally, each cluster has its own architecture and some specific objectives or constraints that may not fit with the available scheduling strategies.

In this thesis, we investigate to ease the development and the use of dynamic scheduling strategies. First we propose to use virtual machines (VMs) to execute the jobs in their legacy environment. In addition, virtualization brings the necessary actions to manipulate VMs as dynamic scheduling strategies manipulate tasks: live migration allows to relocate a VM that embeds a task with a negligible downtime, while the suspend-to-disk and the resume actions provide jobs preemption. To ease the development of specific dynamic scheduling strategies, we propose to use constraint programming (CP), a flexible approach to model and solve combinatorial problems. With this approach, the developer only focuses on modelling its problem by stating the constraints (logical relations) that must be satisfied by the solutions. Hence, we have developed a constraint programming model for a core dynamic scheduling problem as well as additional composable constraints to specify the strategy by restricting the state or the location of VMs. Finally, we introduce the concept of dynamic reconfiguration, a generic method to perform the transition between the current schedule of the VMs and the new computed one. Relying on a model that estimates the duration and the impact on performance of each action, our module, also based on CP plans the actions to ensure their feasibility and to minimize the total duration of their execution.

We have validated our approach with the implementation of a prototype named Entropy[1] which was used to implement two use cases. The first provides dynamic consolidation by packing all the running VMs on the minimum number of nodes while satisfying their CPU and memory resources needs. This strategy reduces the energy consumption of the clusters when unused nodes are turned off. Our second use case reduces the complexity of developing dynamic scheduling strategy. Using the dynamic reconfiguration, the developer only provides an algorithm to select the jobs to run while the reconfiguration module finds a host for each selected VM and provides an efficient transition to reach the new schedule.

We have evaluated Entropy through several experiments using both simulations with up to 200 nodes and 400 VMs and clusters with up to 35 nodes and 70 VMs. We have observed that our approach for dynamic reconfiguration reduces by up to 70% the duration of a reconfiguration as compared to the heuristic *First Fit Decrease* (FFD). This has led to a reactive system that quickly fixes non-optimal schedules and provides an efficient use of resources for each strategy we have developed. For dynamic consolidation, we have compared our implementation with the common heuristic FFD. Our solution performs twice as much reconfigurations and uses half as much resources to execute the same workload. For our second strategy, we have developed a sample scheduling algorithm, similar to *First Come, First Serve* but which executes a workload of 11 jobs 40% faster.

References

International conferences

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[1] http://entropy.gforge.inria.fr

[1] Corentin Dupont, Fabien Hermenier, Thomas Schulze, Robert Basmadjian, Andrey Somov, and Giovanni Giuliani. Plug4green: A flexible energy-aware VM manager to fit data centre particularities. *Ad Hoc Networks*, 25, Part B:505 – 519, 2015. New Research Challenges in Mobile, Opportunistic and Delay-Tolerant NetworksEnergy-Aware Data Centers: Architecture, Infrastructure, and Communication.

[2] F. Hermenier, J. Lawall, and G. Muller. Btrplace: A flexible consolidation manager for highly available applications. *Dependable and Secure Computing, IEEE Transactions on*, 10(5):273–286, Sept 2013.

International journals

[3] Sergey Blagodurov, Alexandra Fedorova, Evgeny Vinnik, Tyler Dwyer, Fabien Hermenier. Multi-objective job placement in clusters. In *Supercomuting'15 - Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis.*, November 2015. acceptance rate: 22%.

[4] Corentin Dupont and Mehdi Sheikhalishahi and Federico M. Facca and Fabien Hermenier. An energy aware framework for virtual machine placement in cloud federated data centres. In *8th IEEE/ACM International Conference on Utility and Cloud Computing*, December 2015. acceptance rate: 27.5%.

[5] Vincent Kherbache, Fabien Hermenier, ric Madelaine. Scheduling Live-Migrations for Fast, Adaptable and Energy Efficient Relocation Operations. In *8th IEEE/ACM International Conference on Utility and Cloud Computing*, December 2015. acceptance rate: 27.5%.

[6] Fabien Hermenier and Robert Ricci. How to build a better testbed: Lessons from a decade of network experiments on emulab. In Thanasis Korakis, Michael Zink, and Maximilian Ott, editors, *Testbeds and Research Infrastructure. Development of Networks and Communities*, volume 44 of *Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering*, pages 287–304. Springer Berlin Heidelberg, 2012. acceptance rate: 30%. **Best paper award**.

[7] C. Dupont, G. Giuliani, F. Hermenier, T. Schulze, and A. Somov. An energy aware framework for virtual machine placement in cloud federated data centres. In *Future Energy Systems: Where Energy, Computing and Communication Meet (e-Energy), 2012 Third International Conference on*, pages 1–10, May 2012. acceptance rate: 34%.

[8] Fabien Hermenier, Sophie Demassey, and Xavier Lorca. Bin repacking scheduling in virtualized datacenters. In Jimmy Lee, editor, *Principles and Practice of Constraint Programming CP 2011*, volume 6876 of *Lecture Notes in Computer Science*, pages 27–41. Springer Berlin Heidelberg, 2011. acceptance rate: 30%.

[9] Nicolas Beldiceanu, Fabien Hermenier, Xavier Lorca, and Thierry Petit. The increasing nvalue-constraint. In Andrea Lodi, Michela Milano, and Paolo Toth, editors, *Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems*, volume 6140 of *Lecture Notes in Computer Science*, pages 25–39. Springer Berlin Heidelberg, 2010.

[10] Fabien Hermenier, Xavier Lorca, Jean-Marc Menaud, Gilles Muller, and Julia Lawall. Entropy: A consolidation manager for clusters. In *Proceedings of the 2009 ACM SIGPLAN/SIGOPS International Conference on Virtual Execution Environments*, VEE '09, pages 41–50, New York, NY, USA, 2009. ACM. acceptance rate: 35%.

[11] L.D.B. Navarro, R. Douence, F. Hermenier, J.-M. Menaud, and M. Sudholt. Aspect-based patterns for grid programming. In *Computer Architecture and High Performance Computing, 2008. SBAC-PAD '08. 20th International Symposium on*, pages 141–148, Oct 2008. acceptance rate: 38%.

International workshops

[12] Vincent Kherbache, Eric Madelaine, and Fabien Hermenier. Planning live-migrations to prepare servers for maintenance. In Lus Lopes, Julius ilinskas, Alexandru Costan, RobertoG. Cascella, Gabor Kecskemeti, Emmanuel Jeannot, Mario Cannataro, Laura Ricci, Siegfried Benkner, Salvador Petit, Vittorio Scarano, Jos Gracia, Sascha Hunold, StephenL. Scott, Stefan Lankes, Christian Lengauer, Jess Carretero, Jens Breitbart, and Michael Alexander, editors, *Euro-Par 2014: Parallel Processing Workshops*, volume 8806 of *Lecture Notes in Computer Science*, pages 498–507. Springer International Publishing, 2014.

[13] Huynh Tu Dang and Fabien Hermenier. Higher sla satisfaction in datacenters with continuous vm placement constraints. In *Proceedings of the 9th Workshop on Hot Topics in Dependable Systems*, page 1. ACM, 2013.

[14] Fabien Hermenier, Adrien Lbre, Jean marc Menaud, Thme Com, Fabien Hermenier, Adrien Lbre, Jean marc Menaud, and Thme Com Systmes Communicants. Cluster-wide context switch of virtualized jobs. In *VTDC'10 : the 4th Workshop on Virtualization Technologies in Distributed Computing*. ACM, 2010.

[15] Fabien Hermenier, Nicolas Loriant, and Jean-Marc Menaud. Power management in grid computing with xen. In Geyong Min, Beniamino Di Martino, LaurenceT. Yang, Minyi Guo, and Gudula Rnger, editors, *Frontiers of High Performance Computing and Networking ISPA 2006 Workshops*, volume 4331 of *Lecture Notes in Computer Science*, pages 407–416. Springer Berlin Heidelberg, 2006.

Book chapter

[16] Sophie Demassey, Fabien Hermenier, and Vincent Kherbache. Dynamic Packing with Side Constraints for Datacenter Resource Management. In János D. Pintér Giorgio Fasano, editor, *Optimized Packings with Applications*, volume 105 of *Springer Optimization and Its Applications*, pages 19–35 – Chapter 2. Springer International Publishing, 2015.

French publications

[17] Vincent Kherbache, Fabien Hermenier, and Éric Madelaine. Ordonnancement contrôlé de migrations chaud. In *Proceedings of the Conférence en Parallélisme, Architecture et Système, COMPAS'15*, 2015.

[18] Fabien Hermenier, Julia Lawall, Jean-Marc Menaud, and Gilles Muller. Consolidation dynamique d'applications web haute-disponibilit. In *CFSE 2011 : 8me Confrence Francophone sur les Systmes d'Exploitation*, 2011.

[19] Fabien Hermenier, Adrien Lèbre, and Jean-Marc Menaud. Changement de contexte pour tches virtualisées dans les grappes. In *CFSE 2009 : 7ème Conférence Francophone sur les Systmes d'Exploitation*, 2009.

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