Improved resource consolidation for database workloads in a cloud

Antonio Carlos Salzvedel Furtado Junior

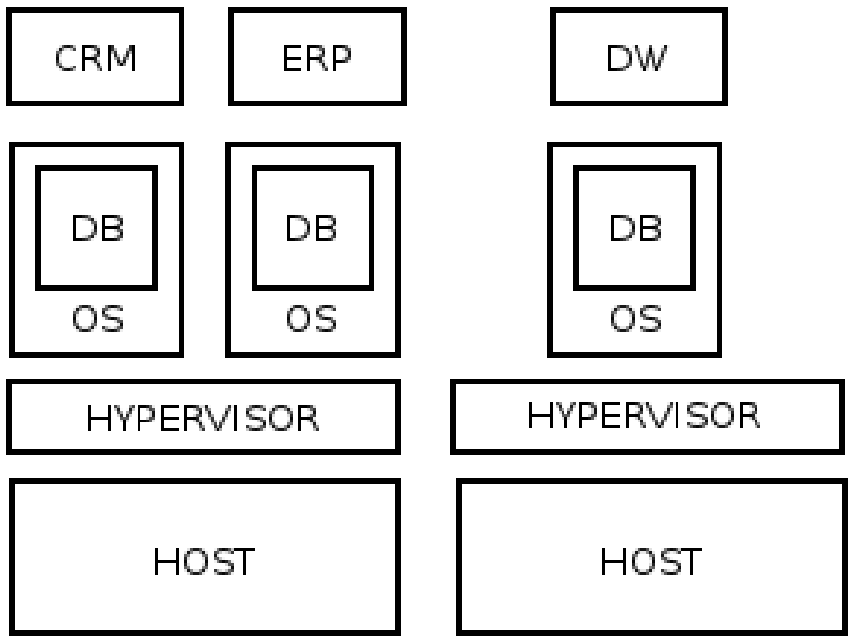
Advisor: Prof. Dr. Eduardo Cunha de Almeida

Department of Informatics
Universidade Federal do Paraná

August 17, 2012

Context

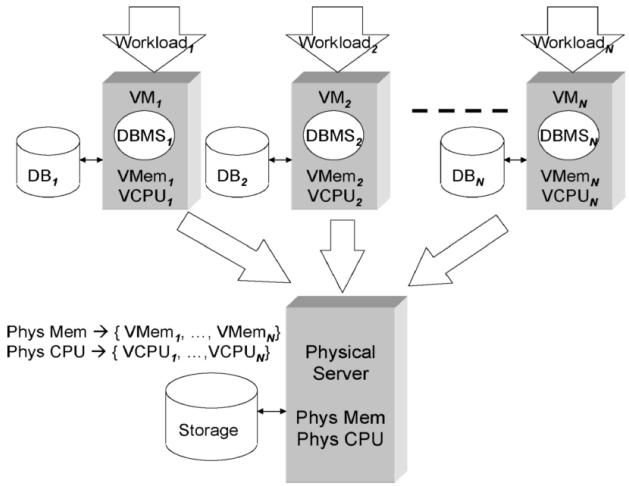
- Private clouds;
- DBMS Virtualization;
- Database consolidation;
- Infrastructure cloud deployment model:



Objective

Problem definition

"Given N database workloads that will run on N database systems inside N virtual machines, how should we allocate the available resources to these virtual machines to get the best overall performance?"[Soror et al., 2007]



Related Work

- [Dias et al., 2005]
  - CPU among distributes systems;
- [Tong et al., 2011]
  - CPU virtualization overhead;
- [Soror et al., 2008] and [Soror et al., 2010]
  - CPU cost models;
  - Virtualization design advisor;

- Objective:
  - Minimize $\sum_{i=1}^{N} Cost(W_i, R_i)$.

Problem

$Cost_{DB}(Q, P_i, D) \longrightarrow Cost(W_i, R_i)$

Cost estimator overview

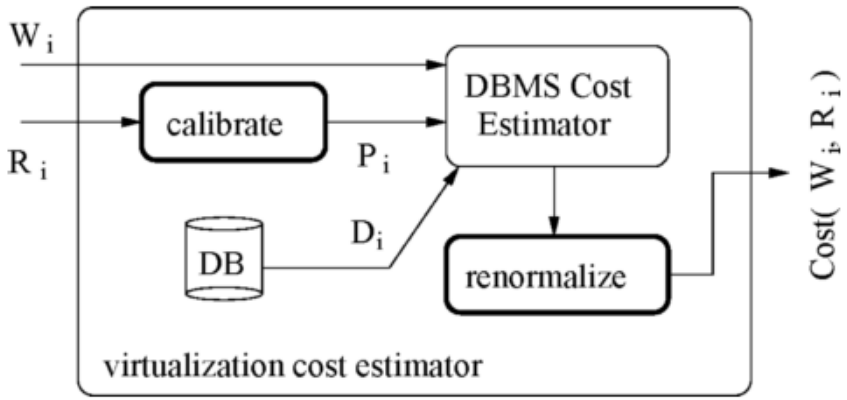


Figure: Cost estimator overview

Advisor overview

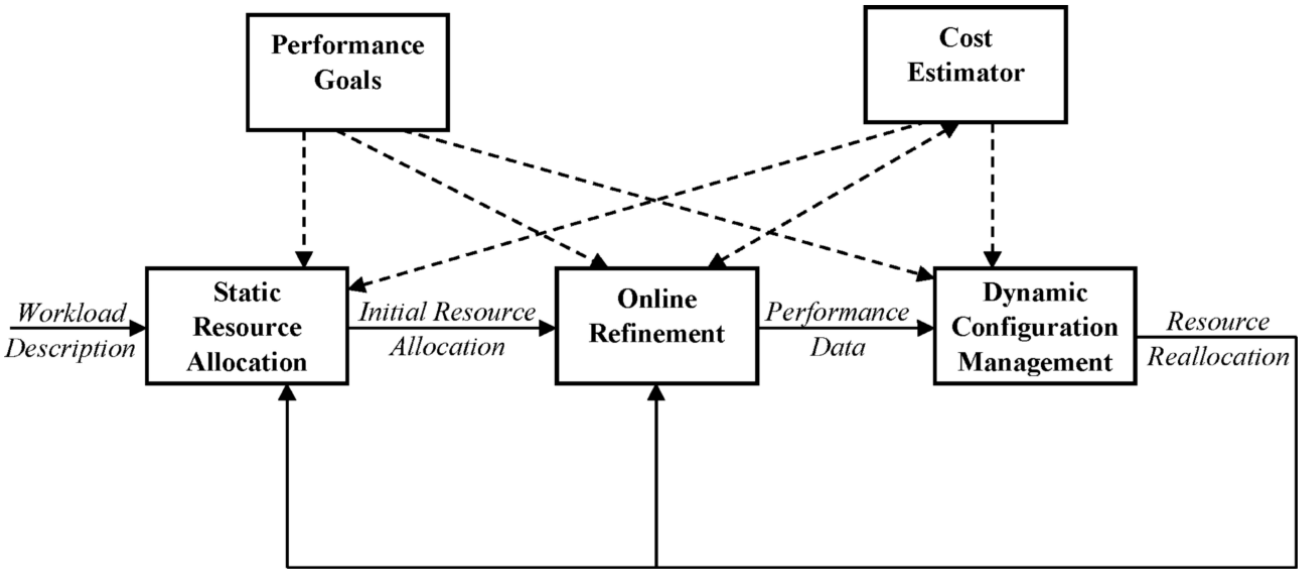


Figure: Advisor overview

OpenNebula

- Homogeneous view of resources;
- Manages VM full life cycle;
- Configurable resource allocation policies;

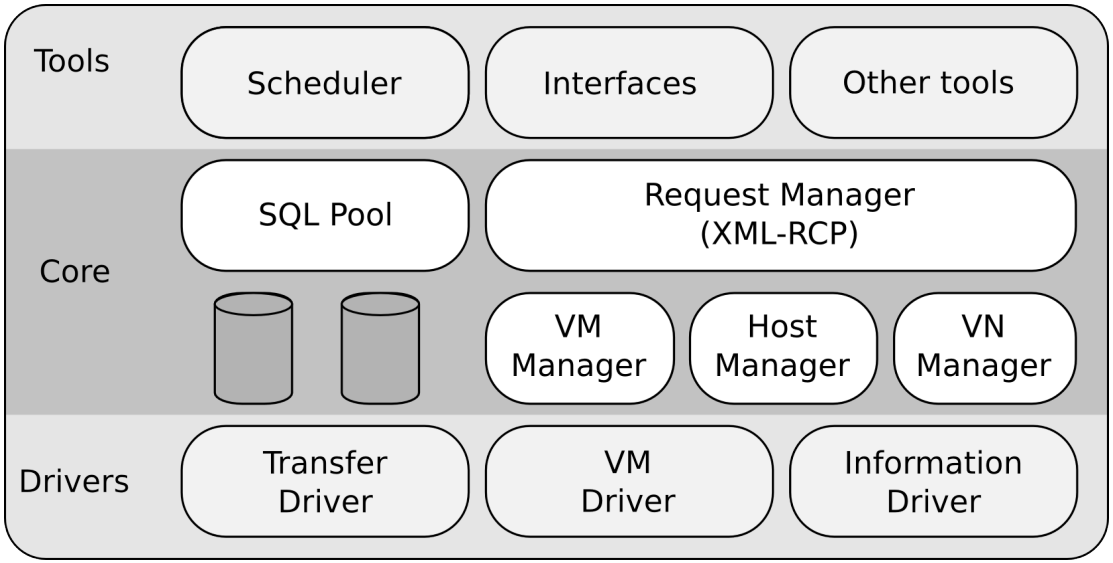
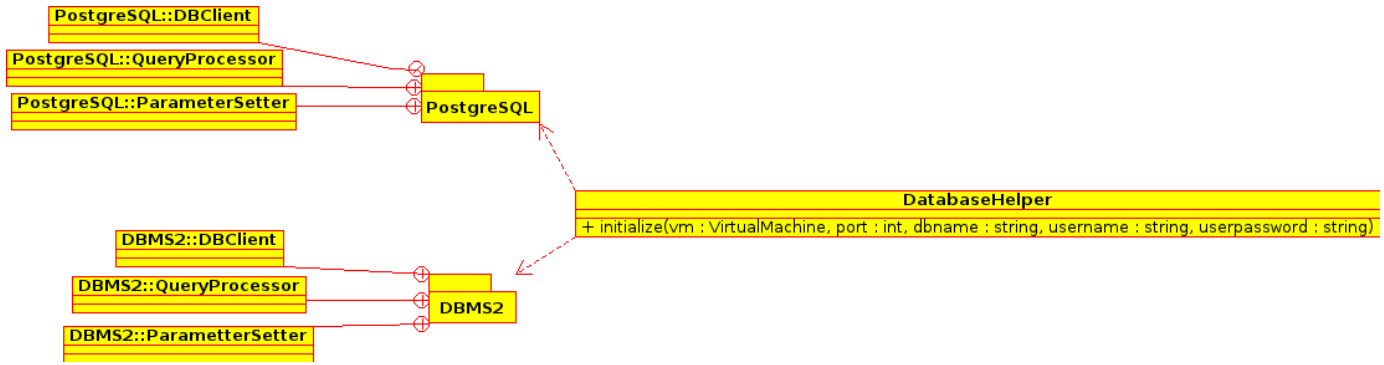


Figure: OpenNebula architecture

OpenRC

- Advisor implementation for a private cloud;
- Supporting features.
  - Resource reallocation;
  - Communication with the DBMS:



Calibration and renormalization

Parameters that describe CPU:

Parameter	Description
cpu_operator_cost	Cost of processing each operator or function call
cpu_tuple_cost	Cost of processing one tuple (row)
cpu_index_tuple_cost	Cost of processing each index entry during an index scan

Normalization in PostgreSQL:

- **seq_page_cost**: Cost of fetching a sequential page from disk.

Relation between costs:

$$param_{estimated} = \frac{param_{actual}}{seq\_page\_cost_{actual}}$$

Implementation Overview

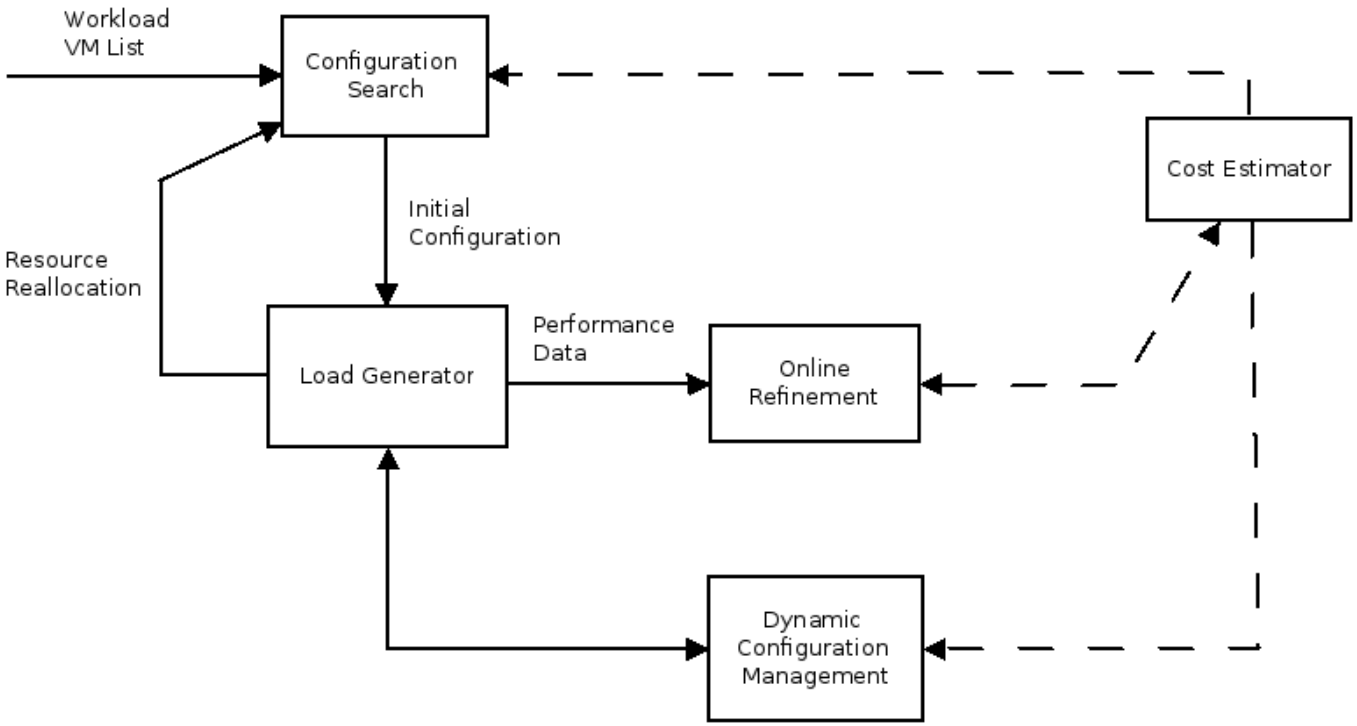
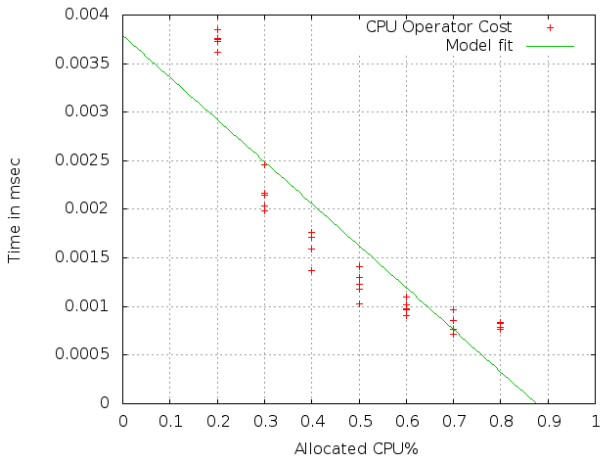
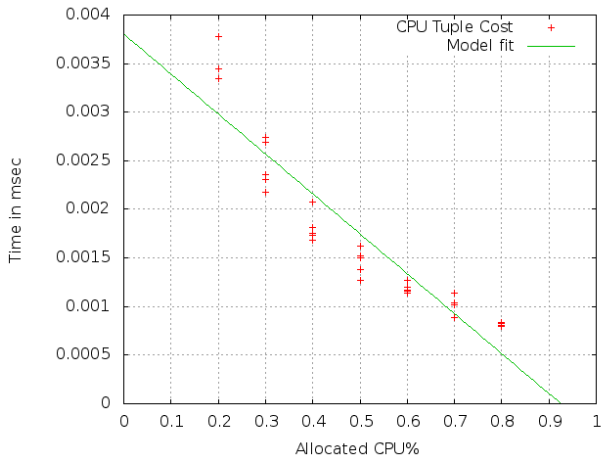
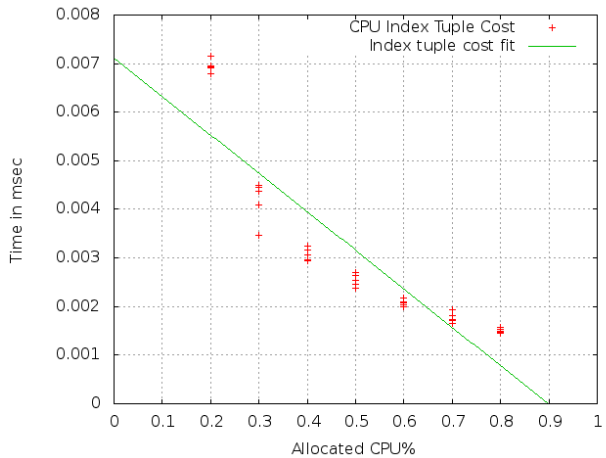


Figure: Implementation overview

Calibration



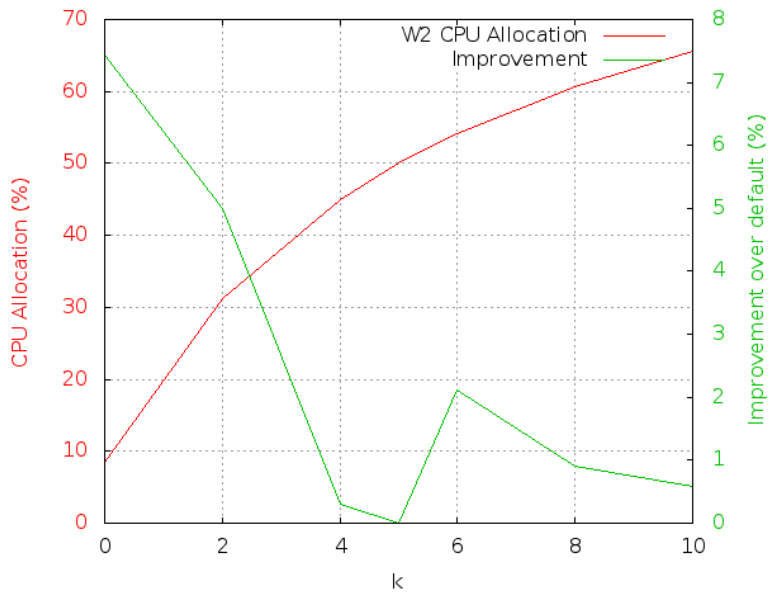




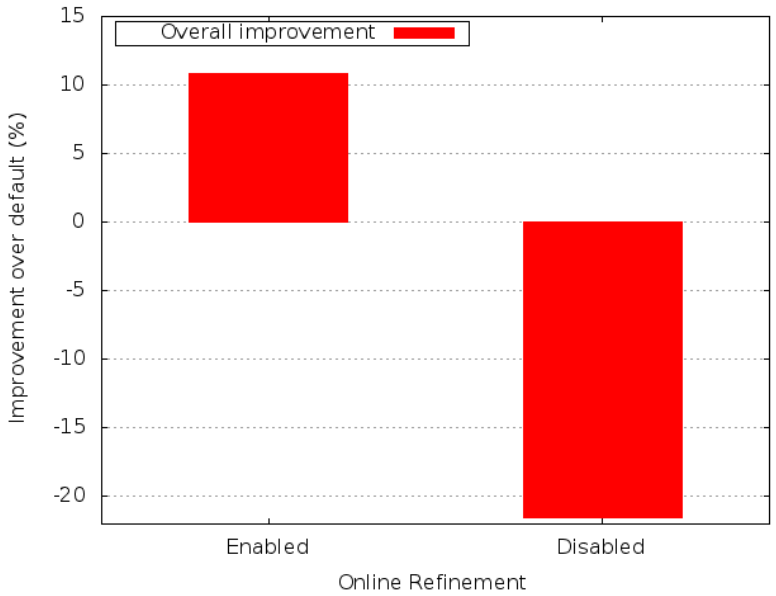
Configuration Search

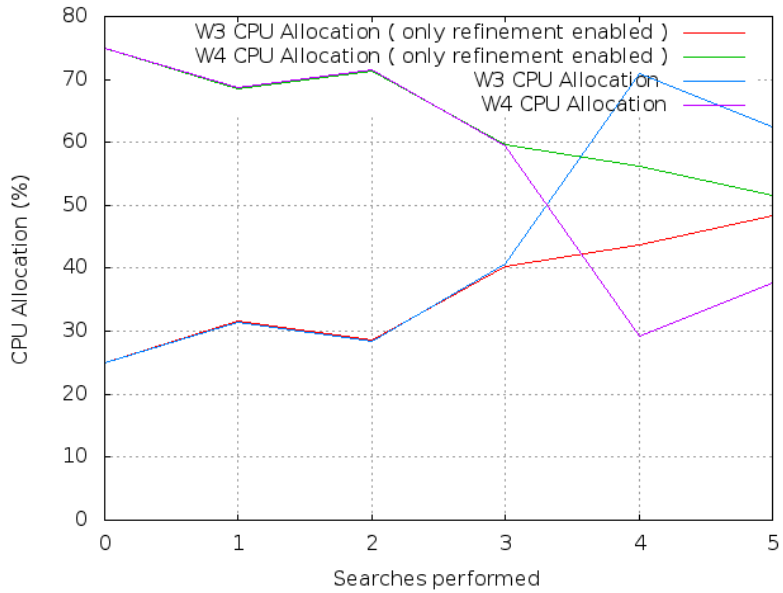
$$\frac{T_{default} - T_{advisor}}{T_{default}}$$

$$\begin{aligned} W_1 &= 5 * C + 5 * I \\ W_2 &= k * C + (10 - k) * I, \\ & \quad 0 \leq k \leq 10 \end{aligned}$$



Online Refinement and Dynamic Configuration Search





Final Considerations

- Resource consolidation on the cloud;
- Improvement over default allocation;
- Future work
  - Different DBMS types;
  - New resources;
  - Explore the infrastructure;
  - Overhead;


Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R. H., Konwinski, A., Lee, G., Patterson, D. A., Rabkin, A., and Zaharia, M. (2009).
Above the clouds: A berkeley view of cloud computing.
Technical report.


Curino, C., Jones, E. P., Madden, S., and Balakrishnan, H. (2011).
Workload-aware database monitoring and consolidation.
In *Proceedings of the 2011 international conference on Management of data*, SIGMOD '11, pages 313–324, New York, NY, USA. ACM.


Dias, K., Ramacher, M., Shaft, U., Venkataramani, V., and Wood, G. (2005).

Automatic performance diagnosis and tuning in oracle.
In *CIDR'05*, pages 84–94.


Kossmann, D. and Kraska, T. (2010).
Data management in the cloud: Promises, state-of-the-art, andÂ open questions.
Datenbank-Spektrum, 10:121–129.
10.1007/s13222-010-0033-3.


Mackert, L. F. and Lohman, G. M. (1989).
Index scans using a finite lru buffer: a validated i/o model.
ACM Trans. Database Syst., 14(3):401–424.


Martin, P., Li, H.-Y., Zheng, M., Romanufa, K., and Powley, W. (2000).

Dynamic reconfiguration algorithm: Dynamically tuning multiple buffer pools.
In Ibrahim, M., KÃ¼ng, J., and Revell, N., editors, *Database and Expert Systems Applications*, volume 1873 of *Lecture Notes in Computer Science*, pages 92–101. Springer Berlin / Heidelberg.
10.1007/3-540-44469-6_9.


Minhas, U., Yadav, J., Aboulnaga, A., and Salem, K. (2008).
Database systems on virtual machines: How much do you lose?

In *Data Engineering Workshop, 2008. ICDEW 2008. IEEE 24th International Conference on*, pages 35 –41.


Soror, A., Aboulnaga, A., and Salem, K. (2007).

Database virtualization: A new frontier for database tuning and physical design.
In *Data Engineering Workshop, 2007 IEEE 23rd International Conference on*, pages 388 –394.

Soror, A. A., Minhas, U. F., Aboulnaga, A., Salem, K., Kokosielis, P., and Kamath, S. (2008).
Automatic virtual machine configuration for database workloads.
In *Proceedings of the 2008 ACM SIGMOD international conference on Management of data*, SIGMOD '08, pages 953–966, New York, NY, USA. ACM.

Soror, A. A., Minhas, U. F., Aboulnaga, A., Salem, K., Kokosielis, P., and Kamath, S. (2010).

Automatic virtual machine configuration for database workloads.
ACM Trans. Database Syst., 35(1).


Sotomayor, B., Montero, R., Llorente, I., and Foster, I. (2009).
Virtual infrastructure management in private and hybrid clouds.

Internet Computing, IEEE, 13(5):14 –22.


Soundararajan, G., Lupei, D., Ghanbari, S., Popescu, A. D., Chen, J., and Amza, C. (2009).
Dynamic resource allocation for database servers running on virtual storage.
In *Proccedings of the 7th conference on File and storage technologies*, FAST '09, pages 71–84, Berkeley, CA, USA. USENIX Association.


Storm, A. J., Garcia-Arellano, C., Lightstone, S. S., Diao, Y., and Surendra, M. (2006).
Adaptive self-tuning memory in db2.
In *Proceedings of the 32nd international conference on Very large data bases*, VLDB '06, pages 1081–1092. VLDB Endowment.


Tong, G., Jin, H., Xie, X., Cao, W., and Yuan, P. (2011).
Measuring and analyzing cpu overhead of virtualization system.
In *Services Computing Conference (APSCC), 2011 IEEE Asia-Pacific*, pages 243 –250.


Vengurlekar, N. (2011).
Database Consolidation onto Private Clouds.
Technical report, Oracle Corporation.