CPU consolidation for database workloads in the cloud

Antonio Carlos Salzvedel Furtado Junior

Advisor: Prof. Dr. Eduardo Cunha de Almeida

Department of Informatics
Universidade Federal do Paraná

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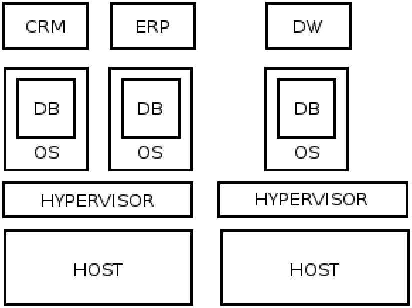
Context

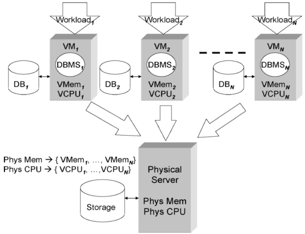
- Private clouds;
- DBMS Virtualization;
- Database consolidation;
- Infrastructure cloud deployment model:



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

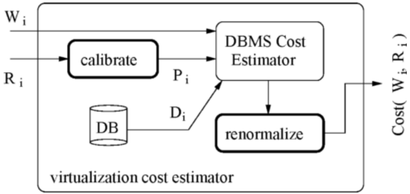


Figure: Cost estimator overview

Advisor overview

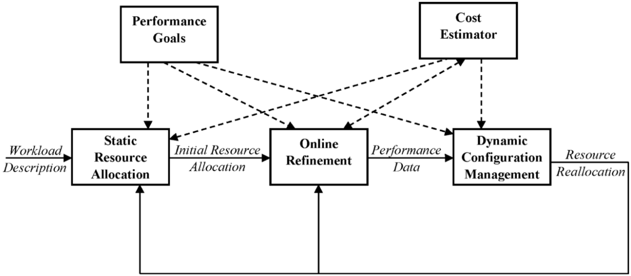


Figure: Advisor overview

OpenNebula

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

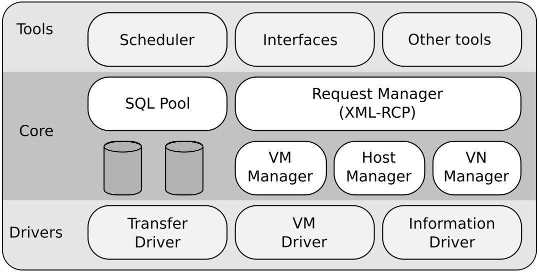
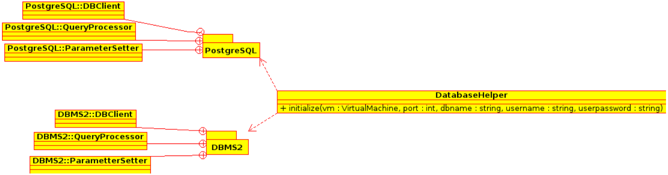


Figure: OpenNebula architecture

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

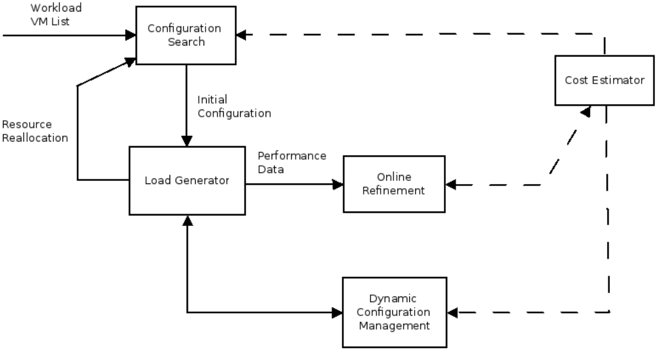
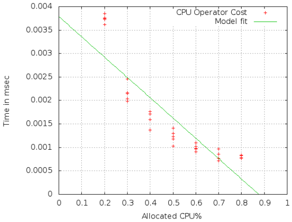
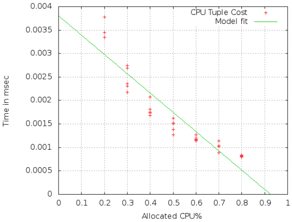
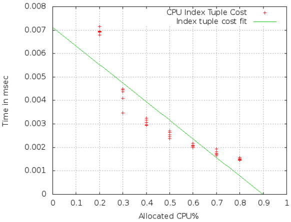


Figure: Implementation overview

Calibration



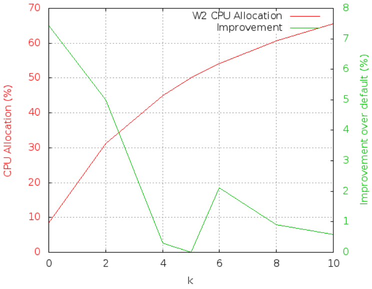




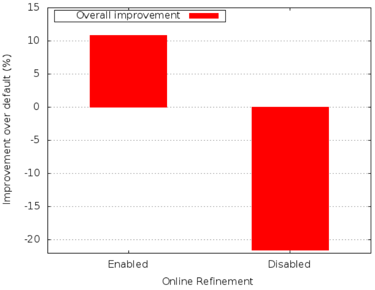
Configuration Search

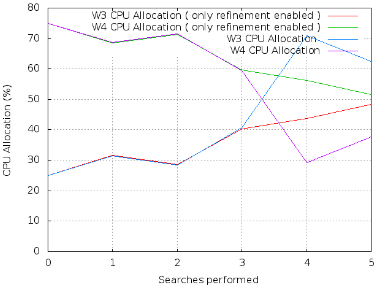
$$\frac{T_{default} - T_{advisor}}{T_{default}}$$

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



Online Refinement and Dynamic Configuration Search





Final Considerations

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

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