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Improved resource consolidation for database workloads in a cloud

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July 12, 2012

Introduction
- Context

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- Overview
- Virtualization Design Advisor

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- OpenNebula
- OpenRC

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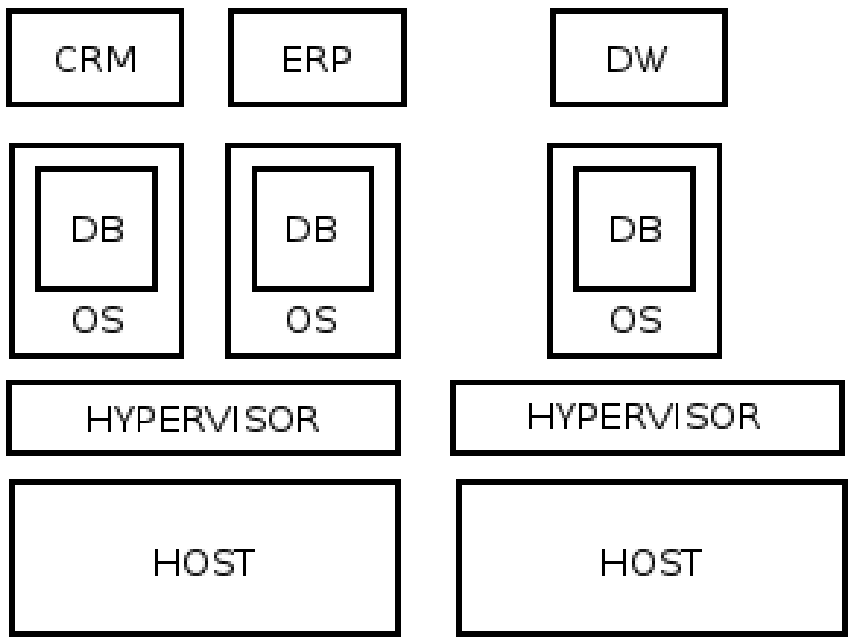
Infrastructure as a service

- Popularized business model;
- On-demand provisioning;
- Offers virtualized resources;
- Private clouds:
  - Flexible infrastructure;
  - Pack services into the same machine;
  - Resource reallocation;
  - Host migration;

Context

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



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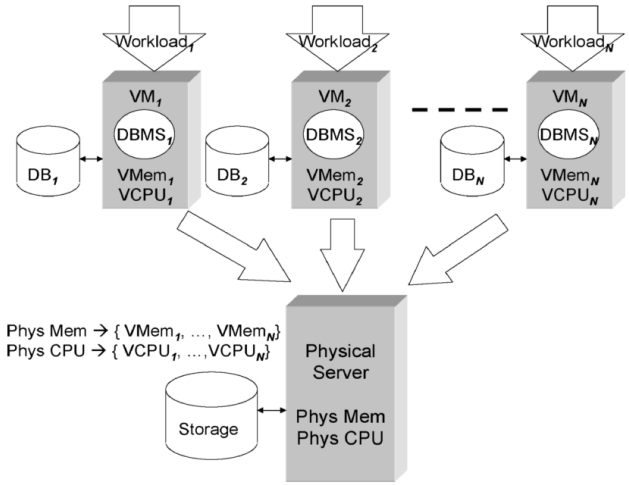
Objective

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 virtual machines to get the best overall performance?"



Database virtualization

- Is it an advantage to virtualize DBMSes?
  - Comparison to non-virtualized database consolidation solution[Curino et al., 2011]
    - Small amount of RAM reclaimed;
    - 6x to 12x higher throughput;
    - Different architecture;
  - According to [Minhas et al., 2008]
    - Average overhead $< 10\%$.
    - Query execution times not much higher;

Resource allocation

- [Soundararajan et al., 2009]
  - Database server running on a virtual storage;
  - Minimal statistics collection;
  - Interplay between resources;
- [Soror et al., 2008]
  - Certain level of independence among resources;
  - Based on query optimizer cost model;
  - VM and DBMS parameters.

- 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

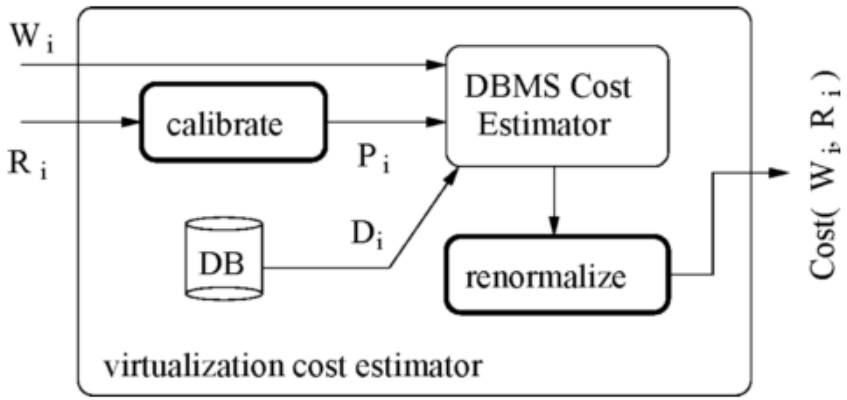


Figure: Cost estimator overview

Advisor overview

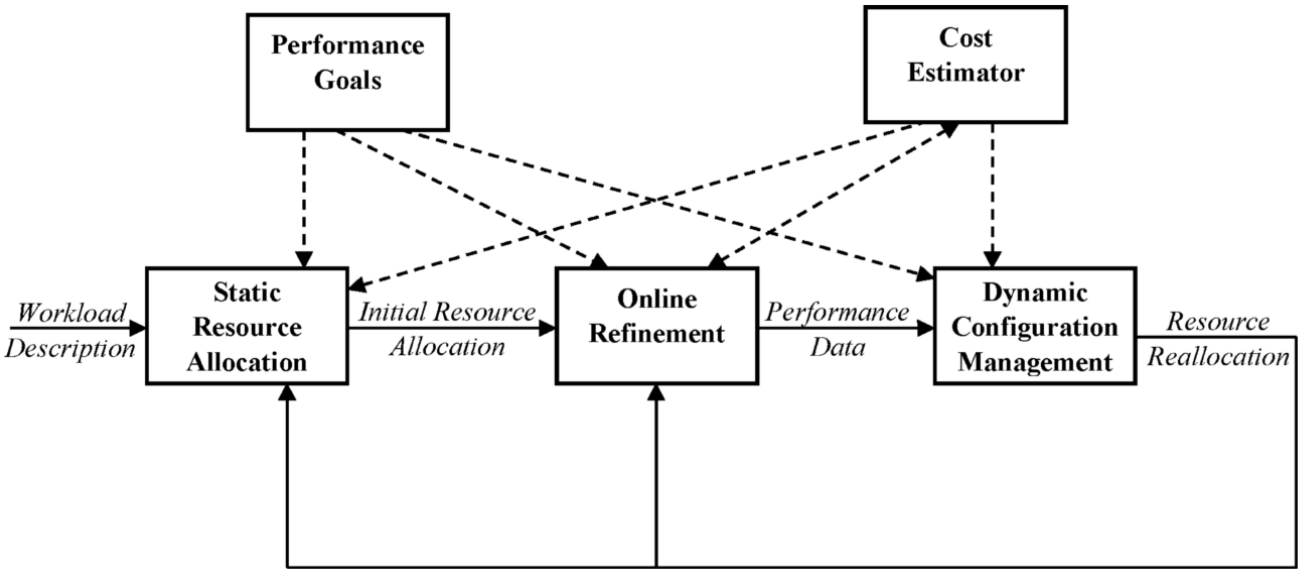


Figure: Advisor overview

OpenNebula

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

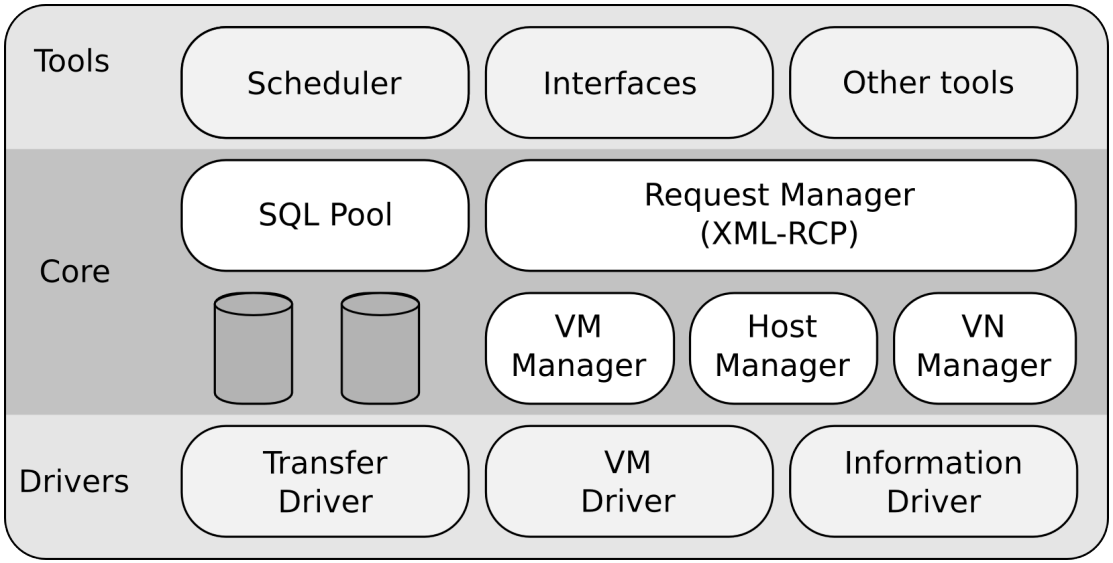
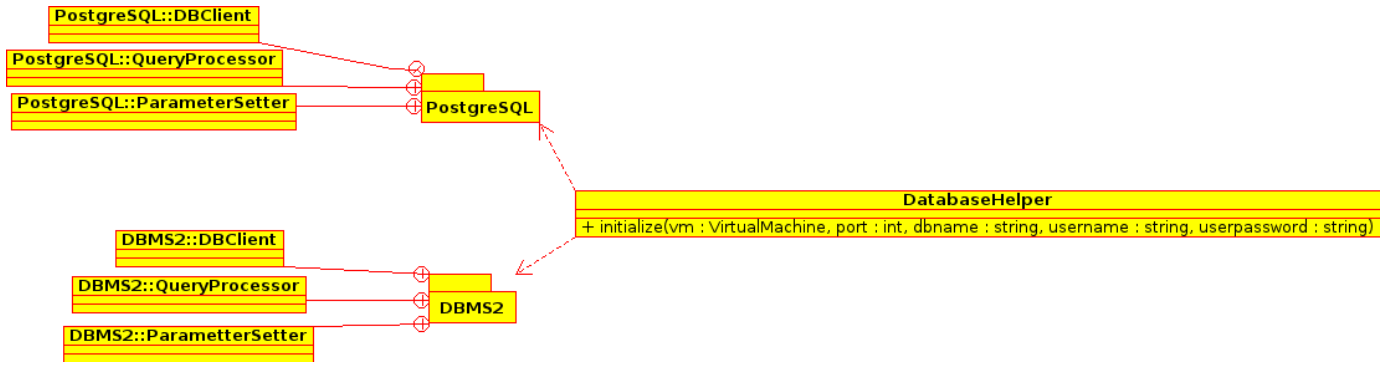


Figure: OpenNebula architecture

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

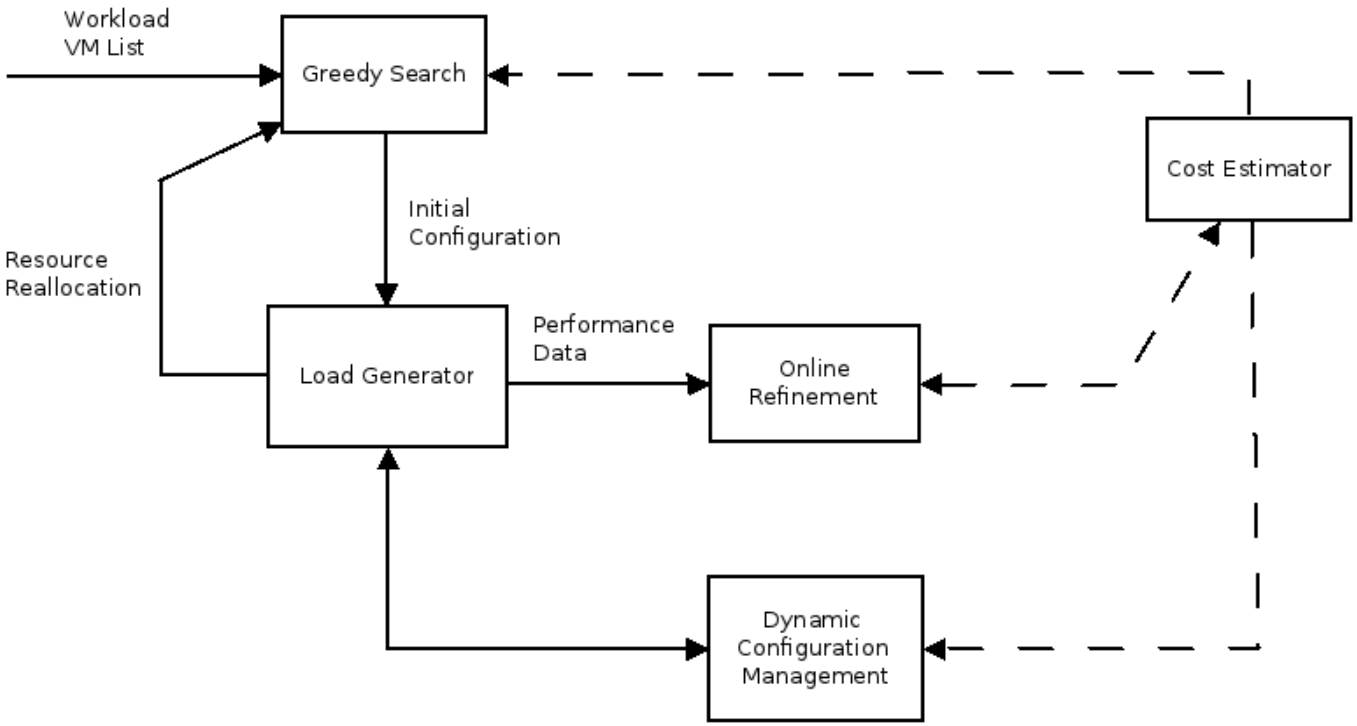
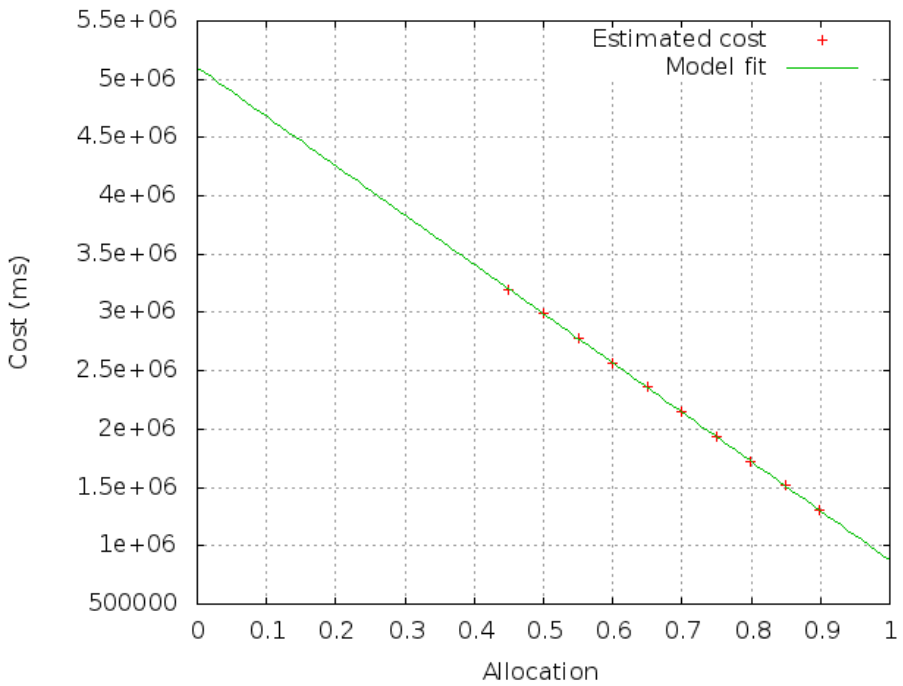
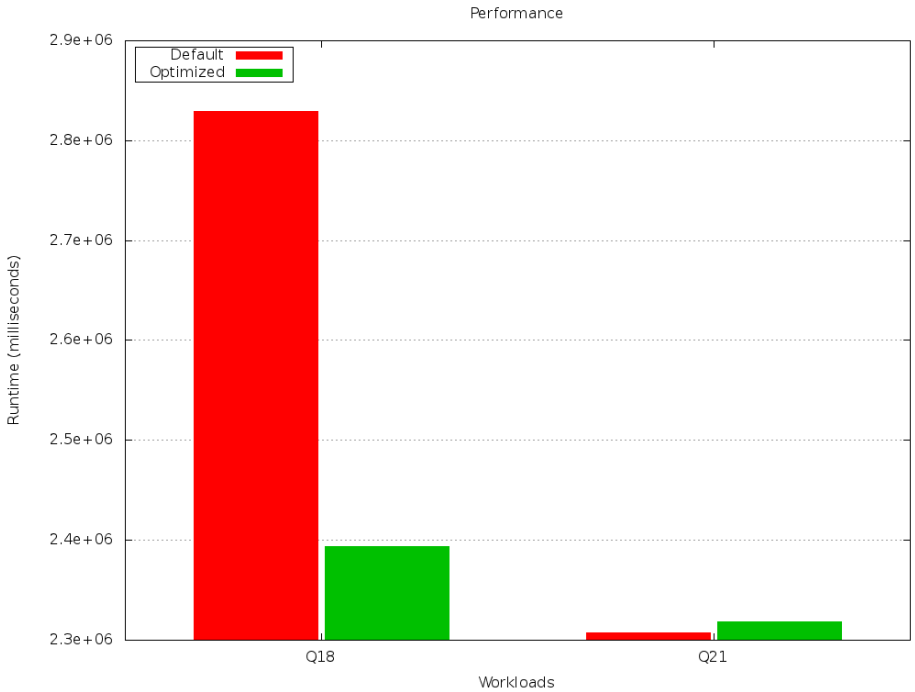


Figure: Implementation overview

Preliminary Results





$\approx$ 8% improvement for 2 workload units

Final Considerations

- Test components;
- Workload variation;
- Result comparison;
- Future work
  - Different DBMS types;
  - New resources;
  - Workload Intensity;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