DCSim: A Data Centre Simulator

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Abstract
Developing algorithms to dynamically manage resources in a virtualized, multi-tenant data centre is challenging. Experimenting with such algorithms on the data centre scale is impractical due to size and complexity. Thus, there is a need for simulation tools to allow rapid development and evaluation of management techniques. We present DCSim [1], an extensible framework for simulating a multi-tenant, virtualized data centre.

Architecture

In DCSim, a data centre consists of a set of interconnected **Hosts** (physical machines), governed by a set of **Management Policies**. Each host has a set of **Resource Managers** that handle local resource allocation, a **CPU Scheduler** which decides how VMs will execute, and a **Power Model** which models how much power is being consumed by the host at any point in time. Each host runs a set of VMs, which in turn each run a single **Application**.

Performance & Scalability

Experiments were performed with varying number of VMs and Hosts, and simulation running time was recorded.

# Hosts	100	1000	10000	1000	1000	1000
# VMs	400	4000	40000	5000	6000	7000
Time	9s	130s	3597s	189s	256s	318s

Metrics

SLA Violation: DCSim reports the percentage of incoming work for which SLA was violated. When a VM requires more resources than it has available to it, some incoming work cannot be completed. This is considered an SLA violation.

Active Hosts: DCSim records the min, max, and average number of hosts *powered on* at any given time.

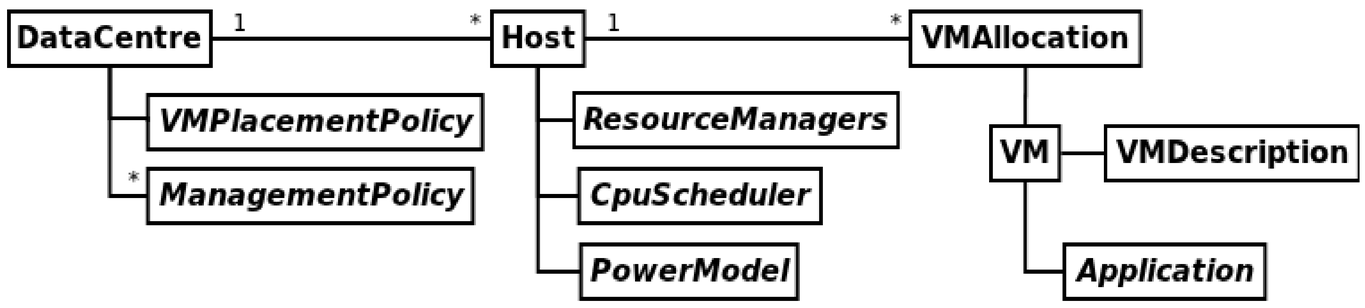
Host-hours: The combined total active time of every host.

Active Host Utilization: The average CPU utilization of *powered on* hosts.

Number of Migrations: The number of live VM migrations performed during the simulation.

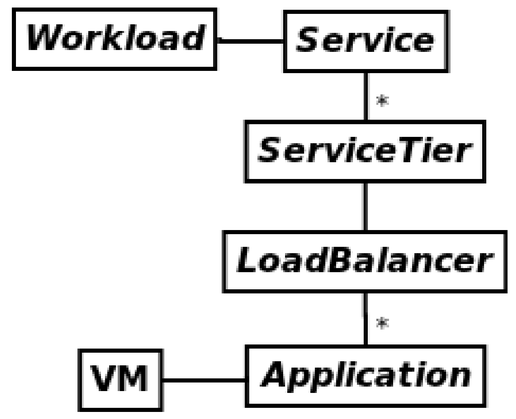
Power Consumption: The total power consumed by the hosts during the simulation.

Algorithm Running Time: DCSim reports the time it took to execute management algorithms to help evaluate algorithm scalability.



Application Model

DCSim provides an application model to simulate VM resource consumption and dependencies between interacting VMs. The primary application model implemented in DCSim simulates a continuous, transaction application, such as a multi-tiered web server.



A **Workload** specifies the amount of incoming work, which can be static, generated randomly, or based on a trace.

A **Service** processes work from the workload in one or more **Service Tiers**. A Service Tier consists of one or more **Applications**, each running within a single VM. The **Load Balancer** for each tier divides work between tier Applications. Once a tier has completed some work, it is forwarded to the next tier for processing.

Current and Ongoing Work Using DCSim

- Comparison of First-fit Heuristics for VM Relocation [2]
- Dynamic Management Strategy Switching [under submission]
- Service Tier Auto-scaling
- Distributed Algorithms for VM Relocation and Consolidation

Future Simulator Improvements

Racks & Clusters: Hosts within the simulated data centre should be organized into racks and clusters. Management decisions could then be made based on this information.

Networking: Network bandwidth and utilization should be modelled within the simulation. This is especially important as it pertains to VM live migration time, bandwidth usage, and effect on other running VMs.

Thermal & Cooling Costs: The heat produced by hosts could be modelled, and cooling costs calculated. Heat could then be taken into consideration by management policies.

Memory Overcommitting: Some virtualization technologies allow memory to be overcommitted, which potentially allows for more VMs to be co-located on a single host.

References

[1] M. Tighe, G. Keller, M. Bauer, and H. Lutfiyya, “DCSim: A data centre simulation tool for evaluating dynamic virtualized resource management,” in SVM Proceedings, 6th Int. DMTF Academic Alliance Workshop on, Oct. 2012. **[2]** G. Keller, M. Tighe, H. Lutfiyya, M. Bauer, “An Analysis of First Fit Heuristics for the Virtual Machine Relocation Problem” in SVM Proceedings, 6th Int. DMTF Academic Alliance Workshop on, Oct. 2012.