A Resource and Policy Aware VM Scheduler for Medium-Scale Clouds

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Problem

Medium Scale Enterprise / University Clouds

Varying user requirements

Limited resources

Complex resource allocations
Solution

Virtual Machine scheduling mechanism

● which is aware of current resource utilization and availability,

● which is aware of defined policies such as user roles and job priorities,

● which performs complex resource scheduling by extending the functionality of a generic IaaS Cloud Framework
# Feature Comparison Among IaaS Platforms

<table>
<thead>
<tr>
<th>Desirable Policies</th>
<th>Eucalyptus</th>
<th>Openstack</th>
<th>Cloudstack</th>
<th>VMware</th>
<th>Our solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Private Clouds</td>
<td>Yes</td>
<td>Yes.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Applicable in small to medium scale</td>
<td>Yes</td>
<td>Yes. But high overhead</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Support for user policies</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Resource-aware scheduling</td>
<td>Static Resources only</td>
<td>Static &amp; Dynamic Resources</td>
<td>Static Resources only</td>
<td>Static &amp; Dynamic resources. DRS performs initial placement when cluster is specified</td>
<td>Static &amp; Dynamic Resources</td>
</tr>
<tr>
<td>Deadline-aware</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Migration support</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Solution Overview

Cloudstack Management Server

Resource allocator and Scheduler

Resource monitor and discoverer

User

Cloudstack managed Cloud Hosts
Evaluation of Technologies

• Resource Monitoring System
  o Nagios [1]
  o Zabbix [2]

• IaaS Platform
  o CloudStack [3]
  o OpenStack [4]
  o Eucalyptus [5]

• Hypervisor
  o Xen [9]
  o KVM [10]

• Programming Language
  o Node.js [8]

• Database
  o MySQL [6]
  o MongoDB [7]
Selected Technologies

ZABBIX

cloudstack

mongoDB

dNode

KVM
High-level Architecture
Core Scheduler Architecture
Resource Requests

<resource_request>
  <group>
    <vm_count>10</vm_count>
    <image>
      <type>iso</type>
      <id>isol</id>
    </image>
    <cpu>
      <cores>1</cores>
      <frequency>1</frequency>
      <unit>GHz</unit>
    </cpu>
    <min_memory>
      <size>2</size>
      <unit>GB</unit>
    </min_memory>
    <min_storage>
      <primary>5</primary>
      <unit>GB</unit>
    </min_storage>
    <priority>3</priority>
  </group>
</resource_request>
Workflow

1. User sends a Resource Allocation Request
2. Authenticate Request
3. Is Authenticated?
   - Yes: Check for Migration Scheduling (MS)
   - No: Return Error message (Unauthorized request)
4. Calculate current resource utilization of the Cloud
5. Resource Utilization information from Zabbix Monitoring System

Allocate resources for the request according to the previous step via CloudStack API

- Is enough resources available for the request?
  - Yes: Allocate resources for the request according to the previous step via CloudStack API
  - No: Return Error message (No enough resources on the Cloud)
Performance Analysis

Resource Aware Virtual Machine Scheduling

Here is a graph showing the available memory (GB) over time for different virtual machines. The time axis runs from 07:02 to 13:58, with a 1-hour interval. The y-axis represents the available memory in GB, ranging from 1.0 G to 4.0 G.

The graph includes lines for different virtual machines, each with different average available memory values as follows:

- VirtualHost1: Available Memory: [avg] last 1.93 G, min 1.45 G, avg 2.34 G, max 258 G
- VirtualHost2: Available Memory: [avg] last 2.65 G, min 1.92 G, avg 2.72 G, max 319 G
- VirtualHost3: Available Memory: [avg] last 2.09 G, min 1.72 G, avg 2.17 G, max 249 G

The graph visually represents how the available memory fluctuates over time for each virtual machine.
Preemptive Scheduling
Challenges/Limitations

- Lack of support for KVM VM memory snapshots in CloudStack
- Issues in setting up cloud infrastructure
- Inconsistent Documentation
- Issues in latest CloudStack deployment
Future Work

• Support for Advanced Reservation
• VM Cloning
• Migration support for Virtual Machines with local storage
• Monitoring of VM resource utilization
References


Thank You!