Smart Cloud Engine and Solution based on Knowledge Base

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Context and Motivations

• Relevant ICT infrastructures are presently deployed on cloud to manage resources in an efficient manner
  – Cloud Customer vs Cloud Service Provider, CSP
  – Service Level Agreements, SLA

• Smart Cloud Solutions are becoming mandatory to increase resilience, reliability in cloud automation:
  – configuration/reconfiguration
  – dynamic scaling, elastic computing, migration, cloning, ..
  – cloud resources healthiness control
  – SLA management
Automation of cloud management

- formal verification and validation of cloud configuration in terms of resources, their relationships
- verification and reasoning about cloud security
- interoperability among public and private clouds
- discovering and brokering services and resources
- reasoning about cloud workload conditions, may be via simulation
- computing capability for horizontal and/or vertical scaling, thus elastic computing
Smart Cloud Engine, SCE

Cloud Services and Administrators

- CCM, Cloud Configuration Manager
- Orchestrator

Cloud Services

- SaaS
- PaaS
- IaaS

Cloud Services Final Users

Supervisor & Monitor, SM

Smart Cloud Administration

- SCE Management Interface and Tools
  - Distributed SCE Scheduler
  - Graphs
  - Editors

Knowledge base

Knowledge Base on RDF Store

Linked Open Graph Service
**SCE Main Features**

- **Receiving** business configurations, BC, and their SLA
- **Receiving** requests for verification and validation of specific BCs, → providing back:
  - Ack about consistency and completeness of a BC, and config.
  - suggestions, hints related to feasibility,
- **Automatically Assessing** sporadic and/or periodic tasks for
  - monitoring of the SLA associated with each single contract element
  - control of the health/security of any: BC, resource, service on the cloud at any level
  - controlling firing conditions activating reconfiguration strategies associated with BCs: scaling, cloning, migration, alarms, etc.
- **Allowing** the integration of SCE with a range of Cloud Management solutions: CCM and Orchestrators
Sequence diagram

CCM

KB

SM

SCE

deployRequest

putBusinessConf

putBusinessConf

nagiosSetup

querySLA

updateSLA

SLA Check Process

storeMetrics

getMetrics

storeMetrics

getMetrics

storeMetrics

getMetrics

evalSLA

storeAlarm

evalSLA

storeAlarm
**Smart Cloud Engine**

- **SCE Management interface**
  - Monitoring status/Logs of activated processes
  - Manual Action Rules
  - Decision support, alarms

- **DISCES**: a distributed scheduler for executing agents for automated computing
  - Monitoring processes
KB Internal Architecture

ICARO Cloud KB API REST

DataCenter Metrics BCs & SLA Applications SPARQL Proxy

Verification Support

Apache Tomcat

Supervisor & Monitor, SM RDF Store (OWLIM-SE 4.3)

SPARQL 1.1 Protocol SPARQL 1.1 Graph Store Protocol

Linked Open Graph

http://log.disit.org
Linked Open Graph, LOD tool
http://log.disit.org
For knowledge base browsing
Metric graphs per: BC/SLA, VM, Service, ...

- ECLAP social network:
  - [http://www.eclap.eu](http://www.eclap.eu)
  - 1 balancer
  - 2 web front ends
  - 1 back office for DB
  - Grid Scheduler and nodes for content ingestion and processing (N VM, 2 in this case)
### Experimental Results

<table>
<thead>
<tr>
<th>Service Metric Monitored as the average value of 30 minutes on values assessed every 5 minutes</th>
<th>% of overvalues with respect to reference values expected as defined in the SLA</th>
<th>Incidence of overvalues with respect to the total number of measures (time slots) performed for the business configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Usage</td>
<td>73.76%</td>
<td>11.86%</td>
</tr>
<tr>
<td>Disk Usage</td>
<td>54.03%</td>
<td>8.57%</td>
</tr>
<tr>
<td>Network workload</td>
<td>24.29%</td>
<td>3.85%</td>
</tr>
<tr>
<td>MySQL DB Size</td>
<td>59.55%</td>
<td>2.12%</td>
</tr>
<tr>
<td>CPU Usage</td>
<td>0.07%</td>
<td>0.01%</td>
</tr>
<tr>
<td>Apache HTTP response time</td>
<td>0.1%</td>
<td>0.008%</td>
</tr>
<tr>
<td>MySQL Connections resp. time</td>
<td>0.1%</td>
<td>0.004%</td>
</tr>
<tr>
<td>Tomcat HTTP response time</td>
<td>0.08%</td>
<td>0.003%</td>
</tr>
</tbody>
</table>

- 26.44% of the assessed time slots were affected by some overvalue, that may be associated to alarms for the detection of critical conditions
- collecting 3 months of data about service metrics, with about 3800 evaluations per metric per day
• **Strategy Condition Editor** for Elastic Cloud programming
  
  - Boolean rules with arbitrary complexity to activate procedures for scaling, migration, cloning, thus actuating solutions of control, balancing, self-regulation, etc.
  
  - Conditions are evaluated on the basis of HLM and SLA for Services, VM, and Business Configurations with respect to absolute thresholds or percentages
ICARO Cloud project

- **Partners**: ComputerGross CSP and LiberoLogico
- **Objectives**: Reduce costs for managing on cloud complex configurations → Business Configurations with Service Level Agreements, SLA
  - Provides simple solutions for moving SW applications on Cloud
  - Automating cloud activities as: configurations, management, monitoring, control, reconfigurations
  - Managing high level metrics, HLM, at applicative level and managing BC with HLM on SLA
ICARO Cloud Architecture

Application Access on iCaro cloud Applications

SME
Access to BPaaS, Services Purchase
Subscription Portal
Configuration Manager
Business Producer

App Producers
Developers PaaS
CMW SDK

Smart Cloud Engine
Smart Cloud
Knowledge Base
Supervisor & Monitor
Cloud Simulator

SaaS
PaaS
Cloud MiddleWare Services
IaaS
New
New
New

Cloud Management

Developers
PaaS
Progetto iCaro
La piattaforma cloud per l’accelerazione del business delle PMI toscane
[CUP 6408.30122011.026000074]
ICARO architecture with ICLOS

Cloud Administration
- Cloud Configuration Manager
- Orchestrator

Smart Cloud Administration
- Smart Cloud Engine
  - Scheduler
  - Manag. Interf. and Tools
  - Knowledge Base
    - on RDF Store and LOD
- Linked Open Graph Service
- Knowledge base Services

Cloud Simulator
- Simulator GUI
- Simulation Config. GUI
- ICLOS Resource Allocator
- Resource Group Controllers
- Cloud Resources
- Simulator Engine

OnLine Cloud Services For Final Users
- SaaS
- PaaS
- IaaS

Cloud Under Management

Real Cloud Data Traces
- Simulated Cloud Traces
- Model Cloud Data Traces

Supervisor & Monitoring
- Nagios

ICARO:
- architecture
- with ICLOS
Conclusion: The proposed SCE solution

- is based on innovative Knowledge Base: ICARO Cloud Ontology and reasoning tools: BC, SLA, HLM, etc.
- enables a flexible management of cloud resources: verification, control, management: scaling, cloning, migrating, etc. dynamic cloud control
- is scalable and provides smart reasoning for different contexts
- can be easily exploited in connection with any cloud management tools such as configurators, orchestrators, and monitoring tools
- has been validated in ICARO Cloud project with CSPs on complex cloud configurations, and on DISIT cloud multitier solutions with good performance in terms of low operating workload and scalability.
- Supports scalability at level of distributed scheduler for the Smart Cloud Engine, on KB services and on Monitoring.