Energy Efficiency Metaheuristic Mechanism for Cloud Broker in Multi-Cloud Computing

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Introduction

Green@Cloud project (multi-objective metaheuristics for energy-aware scheduling in cloud computing systems):

Introduction:

- an energy efficiency mechanism based on metaheuristic algorithms for a cloud broker in multi-cloud computing
- metaheuristic based algorithm deals with the multiple objectives defined by the cloud users and the Cloud Service Providers (CSPs)

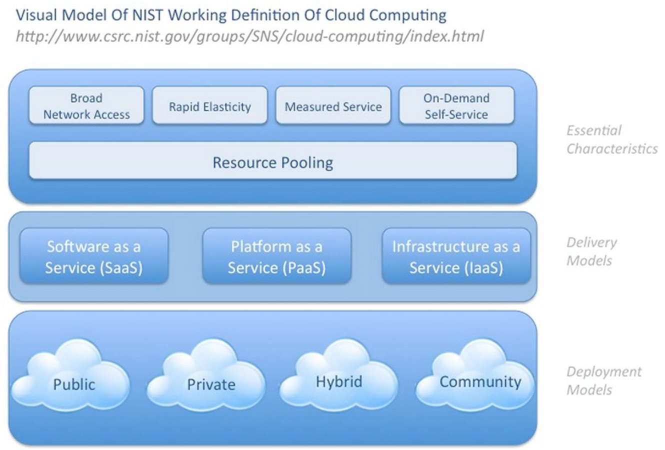
Introduction

Motivation:

- metaheuristic algorithm implemented in ParadisEO focuses on green energy while searching for a balance point that satisfies the objectives: cost and response time
- include a component of prediction model based on Gaussian Mixture Model:
  (1) prediction model for incoming request of VMs from the cloud users
  (2) prediction model to react to the dynamic price model of the CSPs
- integration with simulation GreenCloud to verify the experimental results

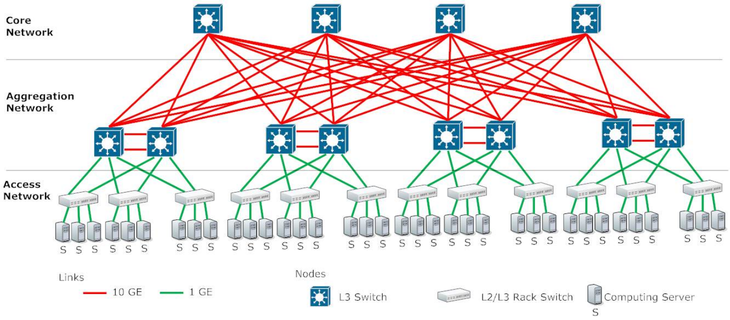
Introduction

Cloud Computing - NIST Definition



Introduction

Cloud Computing - Data Center



Introduction

Cloud Computing - Abstract Layer

Business process
- Business orchestration

Software
- Gmail
- Office365

Platform
- Google cloud
- Container based approach

Infrastructure
- Amazon web services
- Virtual machines

Hardware
- Real hardware
- Hosting

Introduction

Cloud User

The cloud computing paradigm brings the resources of the cloud to the end users in an "all-as-a-services" form

- Software-as-a-Service (SaaS)
- Platform-as-a-Service (PaaS)
- Infrastructure-as-a-Service (IaaS)

Introduction

Cloud User

The problem for the cloud users is to define their specific requirements in terms of services and application deployment

These specific requirements can be categorized into:

- cost of the cloud services
- user concern: response time or performance (the on-running services the cloud users purchased from the CSPs)

Introduction

Design Concept

The CSPs offer services under the Service Level Agreement (SLA) and Quality of Service (QoS) specifications

The characteristics of the services offered by the CSPs:

- price model (on-demand, average monthly price, ...)
- resource plan and SLA/QoS
- other features : virtualization, performance, reliability, and security

Introduction

Design Concept

The design concept :

- bring the green aspect at the cloud broker level by defining optimization objectives for the cost, the response time and the green energy
- use a metaheuristic method for this multi-objective optimization problem that focuses on reducing the cost as well as improving the green energy
- consider the priority for the CSPs that offer their services with high rate of green energy usage

Introduction

Design Concept

Our concept for the cloud broker:

- model price based on the on-line offer from several CSPs: Google, Rackspace, Amazon, HP, Microsoft Windows Azure
- green energy factor about the Green Energy used in the CSP Data Center: Report "How Clean is Your Cloud?" from Greenpeace

Overview

Related Work

In the study of Spillner et al., the authors show that:

- the cloud broker is an interface to manage the virtualized resources between the cloud provider and the cloud user
- collect the underutilized resources to be reused
- proposed a nested VM in which other VMs from multi-cloud providers are referred to as sub-VMs
- the concept of nested VMs helps the cloud broker to deal with a variety of VMs from multi-cloud providers

Related Work

In the study of Usha et al., the authors proposed a framework for cloud brokerage service:

- schedule the cloud resources by considering the multi-criteria objectives of both cloud users and cloud providers
- the proposed model is based on QoS parameters that include the response time and the throughput
- the optimization problem is defined as a multi-criteria optimization problem, using a metaheuristic method to find a solution from the Pareto set

Related Work

Carpentier et al. presented an open source framework called CompatibleOne:

- deals with cloud brokering services inside multi-cloud environments
- there are two important components:
  (a) an energy monitoring module
  (b) a module to interact with the cloud monitoring systems
- the framework's design concept aims to bring the energy efficiency to the cloud broker services

Overview

Proposed Model

Overview

- propose a design concept for a cloud broker based on metaheuristics that focuses on green energy
- method is based on a Evolutionary Multi-Objective Algorithm (EMOA) implement in ParadisEO
- use the EMOA to explore highly-complex spaces and ability to determine efficient Pareto solutions
- integrate cloud broker (ParadisEO) to the simulator GreenCloud to verify the results

Proposed Model

Overview

In our optimization problem, we consider:

- price model and green energy factors from the CSPs
- user-experience parameters (response time)
- prediction model based on Gaussian Mixture Model will be used to deal with:
  (1) predict the incoming requests of VMs from the cloud users
  (2) react to the dynamic price model of the CSPs (eg the Amazon have the bid price for the dynamic price) to obtain the optimized cost
- integration with the simulation to verify the results

Proposed Model

Overview

Price model: in the first step, static model we go with on-demand price model for all the CSPs. We can extend in the future work for more price model in dynamic model: reserved price, bid price (Amazon), monthly pricing plans

- minimizing the cost for the number of VM request x price as the first objective function

Proposed Model

Overview

Green factor: obtained from the report of the Greenpeace about how the green energy is used in the datacenter of the CSPs

- assuming the simple situation: the cost will be related to the price that the CSPs pay for the green energy

Proposed Model

Report "How Clean is Your Cloud?" from Greenpeace

Company	Clean Energy Index	Coal	Nuclear	Energy Transparency	Infrastructure Siting	Energy Efficiency & GHG Mitigation	Renewables & Advocacy
Akamai	NA	NA		A	C	B	D
amazon.com web services	13.5%	33.9%	29.9%	F	F	D	F
	15.3%	55.1%	27.8%	D	F	D	D
DELL	56.3%	20.1%	6.4%	C	C	C	D
facebook	36.4%	39.4%	13.2%	D	B	B	C
Google	39.4%	28.7%	15.3%	B	C	B	A
hp	19.4%	49.7%	14.1%	C	D	B	C
IBM	12.1%	49.5%	11.5%	C	D	C	D
Microsoft	13.9%	39.3%	26%	C	D	C	C

Proposed Model

Report "How Clean is Your Cloud?" from Greenpeace

Facility Location	Status	Sq Footage	Estimated Max Power Demand (MW)	% of Dirty Energy Generation on Local Grid	% of RE Supply to Data Center	CUE	Coal	Nuclear	Clean Energy Index
Google							28.7%	15.3%	39.4%

Proposed Model

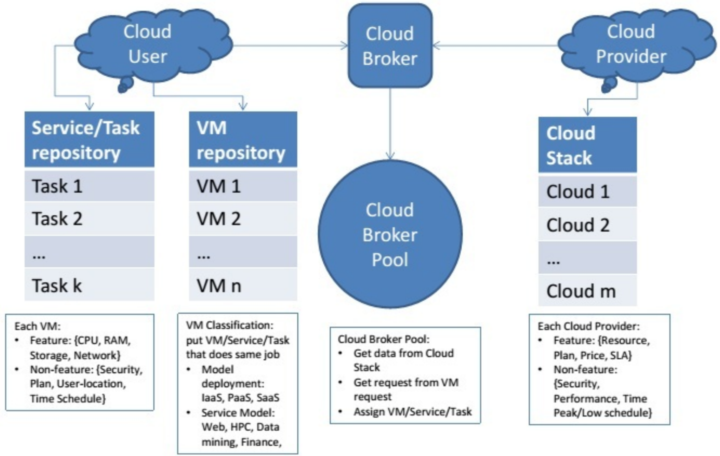
Overview

In our proposed model:

- rely on a multi-objective optimization technique that considers:
  (a) minimizing the operation cost of the CSPs
  (b) improving green energy priority
- react to the dynamic price model from the CSPs and the incoming VMs requests from the cloud users with prediction model based on the Gaussian Mixture Model

Proposed Model

Proposed model of the cloud broker



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- Greenpeace: Make it green: "Cloud computing and its contribution to climate change"
- Greenpeace: "How Clean is Your Cloud", April 2012
- Usha, M., Akilandeswari, J., Fiaz, A.: "An efficient qos framework for cloud brokerage services"

Overview

Conclusion

- the aim of our work is to explore a first draft and conceptual view of a hybrid metaheuristic and prediction model approach
- the approach is expected to improve the green energy priority and the quality of service of the cloud broker
- we aim at not only ensuring energy efficiency but also at dealing in an optimal manner:
  (i) receiving requests from cloud users
  (ii) react to the dynamic price plan from the CSPs
  (iii) assigning tasks/services from a cloud user to a CSP based on the optimized result

Conclusion

Current work:

- implement with ParadisEO (`http://paradiseo.gforge.inria.fr`) and simulation CloudSim (`http://www.cloudbus.org/cloudsim`): NSGA, NSGAII, SPEA2, customized EA
- experimentation and validation on a real test bed using large-scale equipments (e.g. Grid'5000 `http://www.grid5000.fr`)

Thank you for your attention!