Cloud User-Centric Enhancements of the Simulator CloudSim to Improve Cloud Deployment Option Analysis

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Motivation

- Migration of enterprise software to the cloud
- Many different cloud deployment options (e.g., which cloud provider)
- Simulation helps to find the best trade-off between high performance and low costs

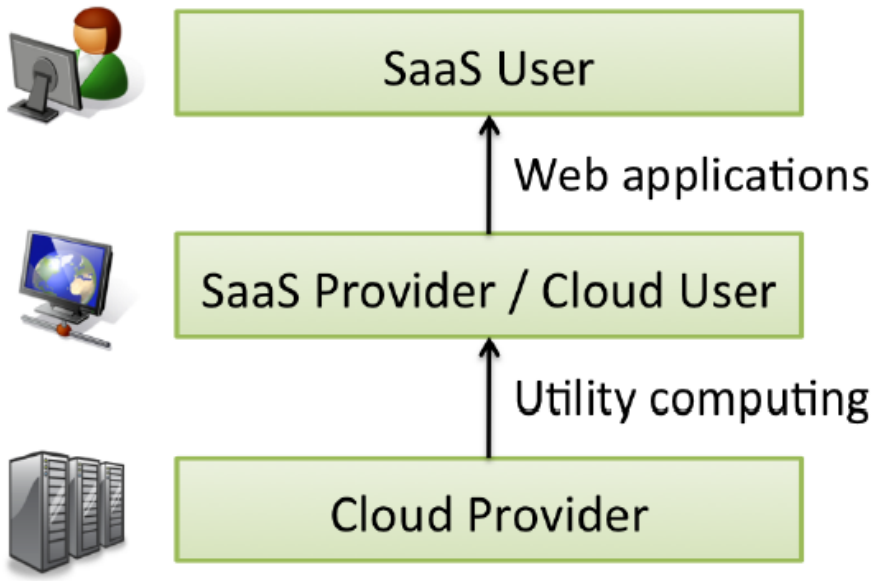
Cloud Deployment Option (CDO)

In the context of a deployment of software on a cloud platform, a cloud deployment option is a **combination of decisions** concerning the

- selection of a cloud provider,
- the deployment of components to virtual machine instances,
- the virtual machine instances' configuration,
- and specific adaptation strategies.

CloudSim and User Perspective

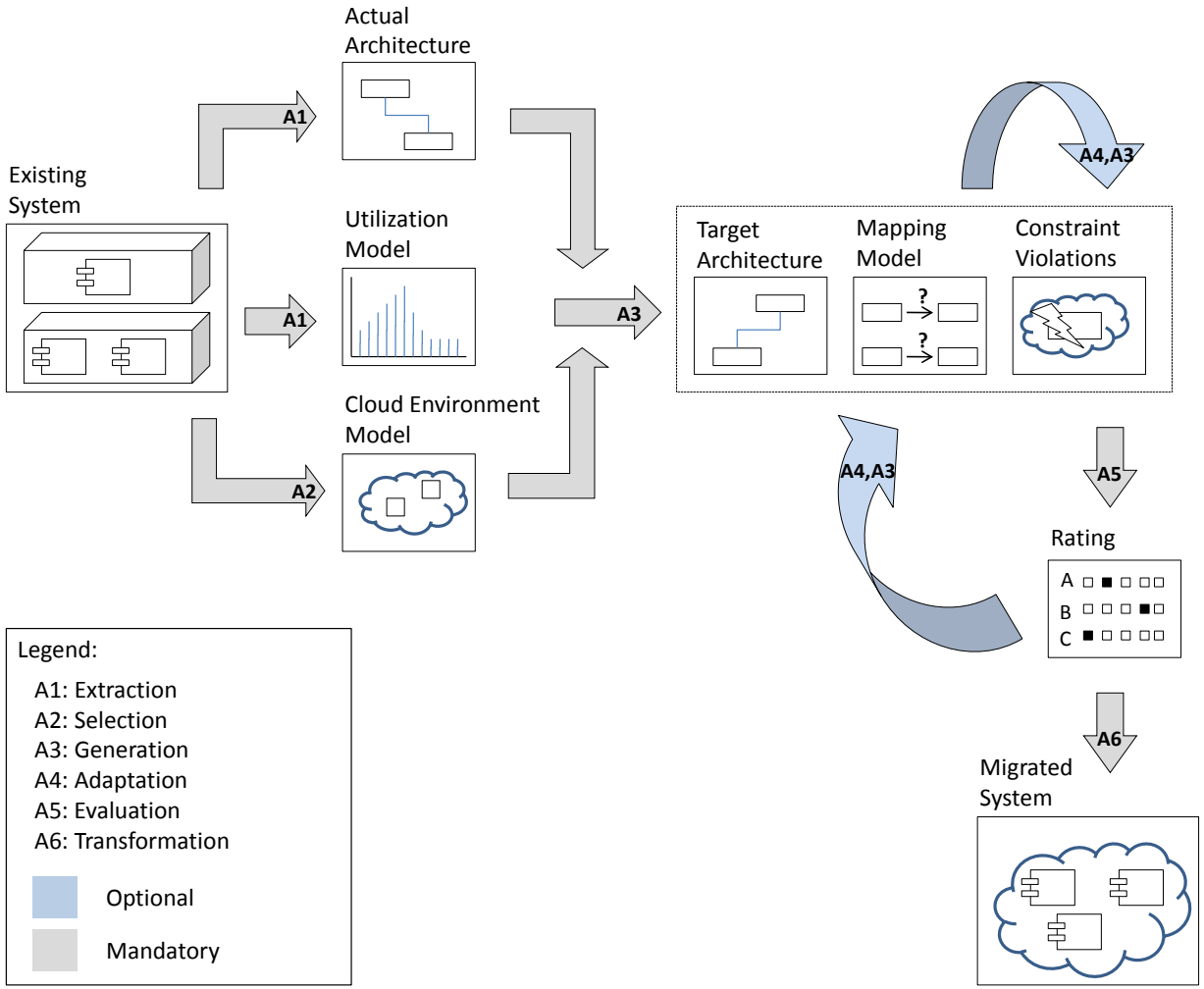
- CloudSim [CRB+11] lacks the cloud user perspective (e.g., elasticity)
- Armbrust et al. [AFG+09] define 3 roles:



CDOSim

- Extends CloudSim by the cloud user perspective
- Simulates occurring costs, response times, and SLA violations
- Integrates in cloud migration framework CloudMIG [FHS12, FH11]

CloudMIG approach



CloudSim and CDOSim

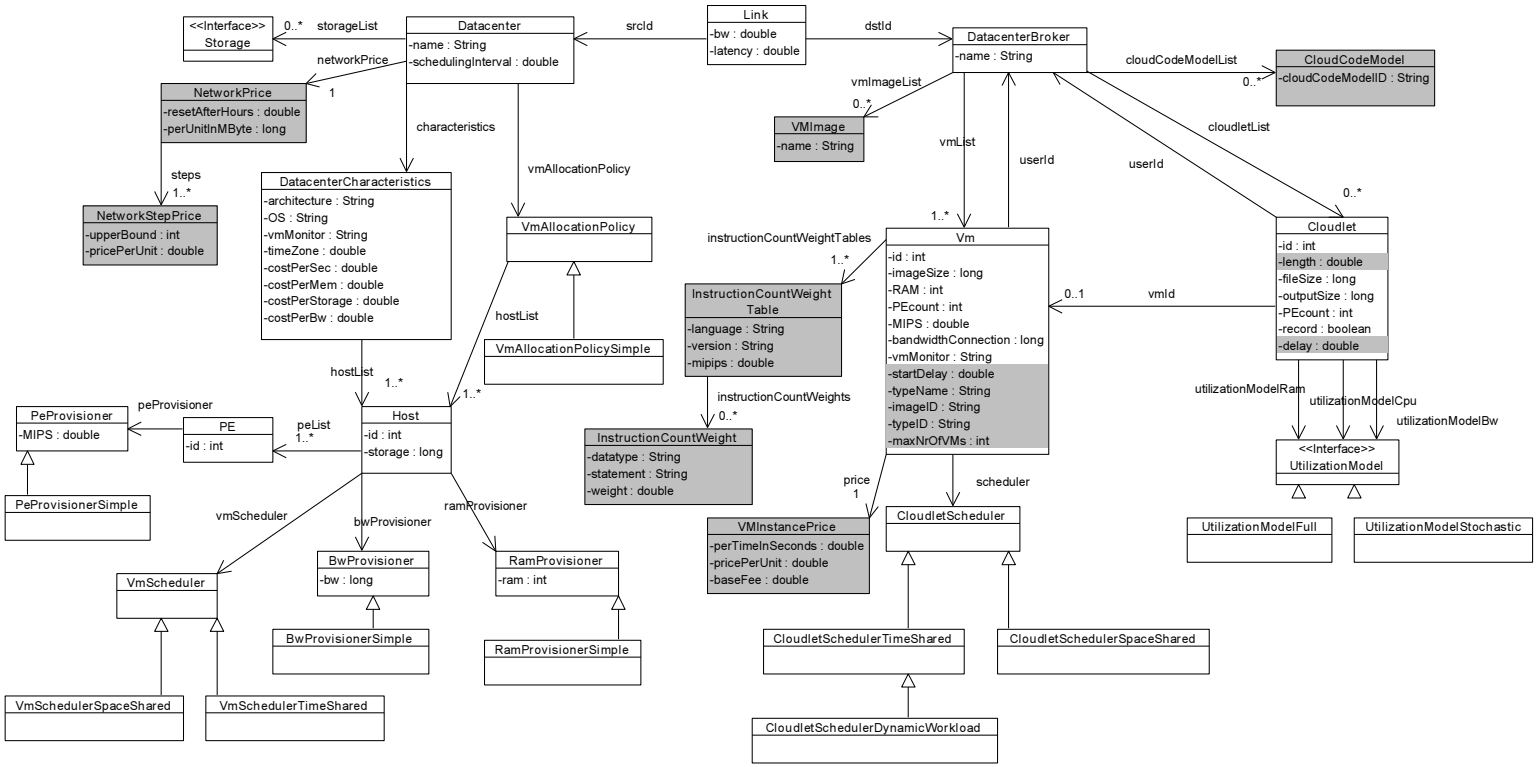
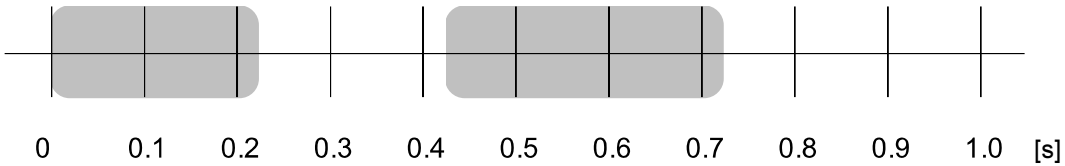


Figure 1 : Enhanced CloudSim meta-model

CloudSim Enhancements

1. CPU utilization model per core



2. Starting and stopping VMs on demand
3. Delayed Cloudlet creation
4. Delayed start of VMs

CloudSim Enhancements cont'd

5. Configurable timeout for Cloudlets
6. Enhanced debt model
7. Method calls and network traffic between VMs

CloudSim Enhancements cont'd

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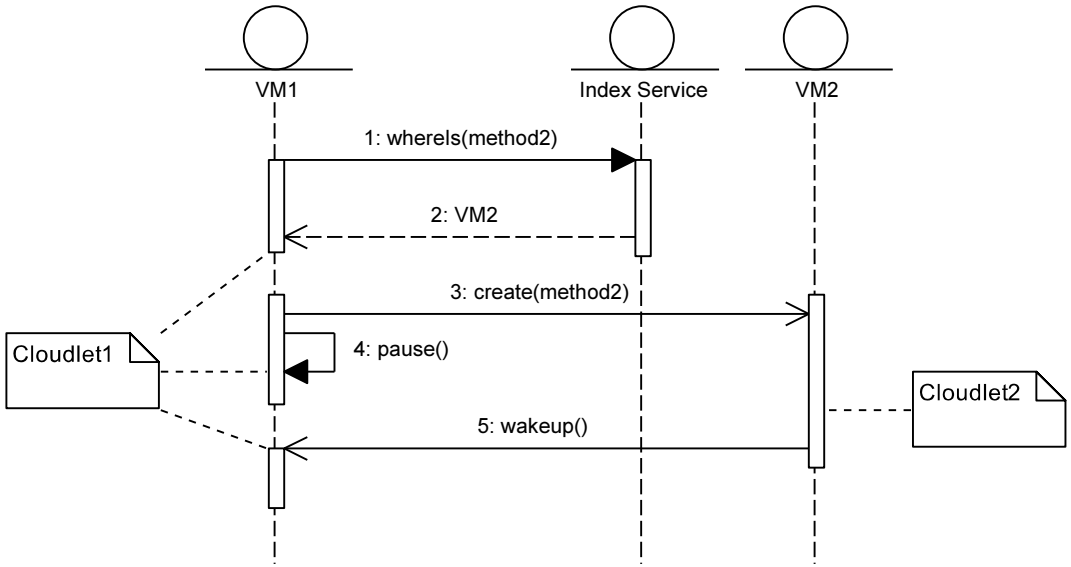
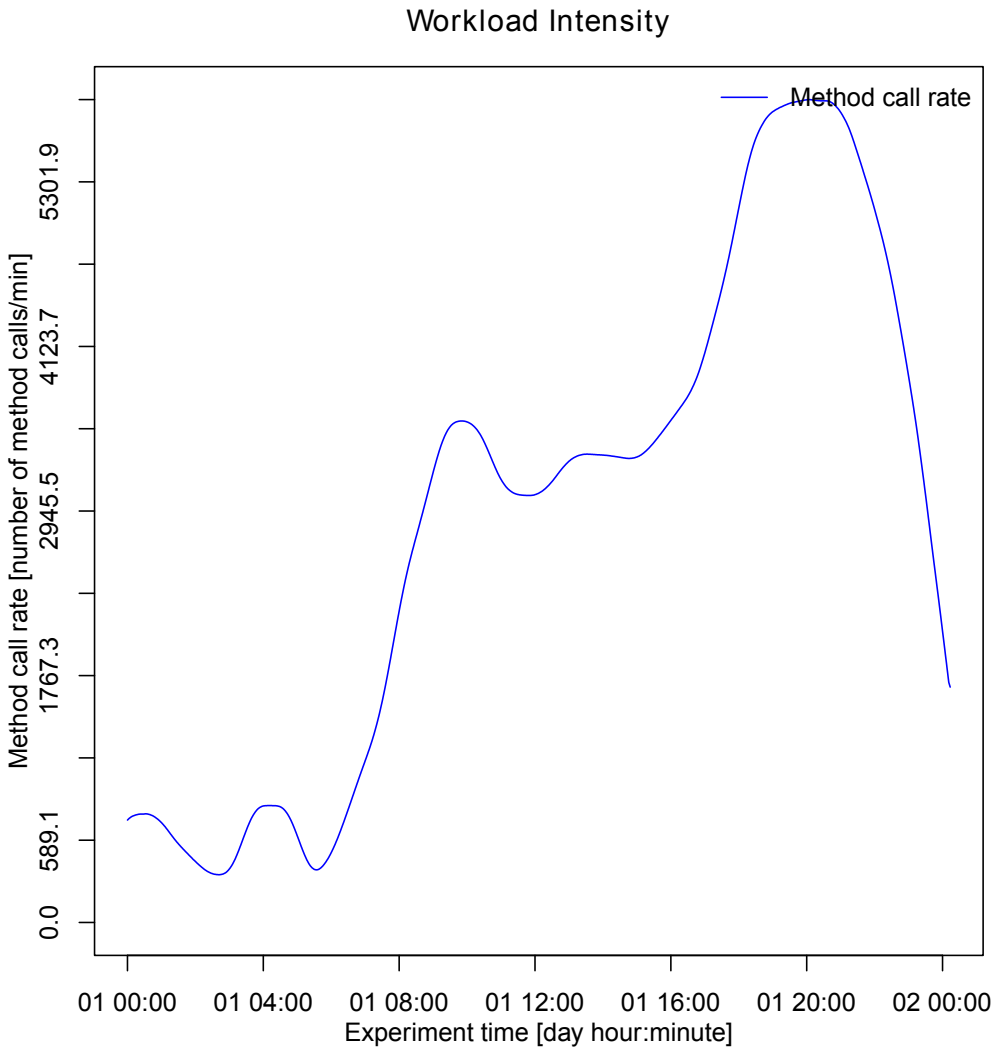


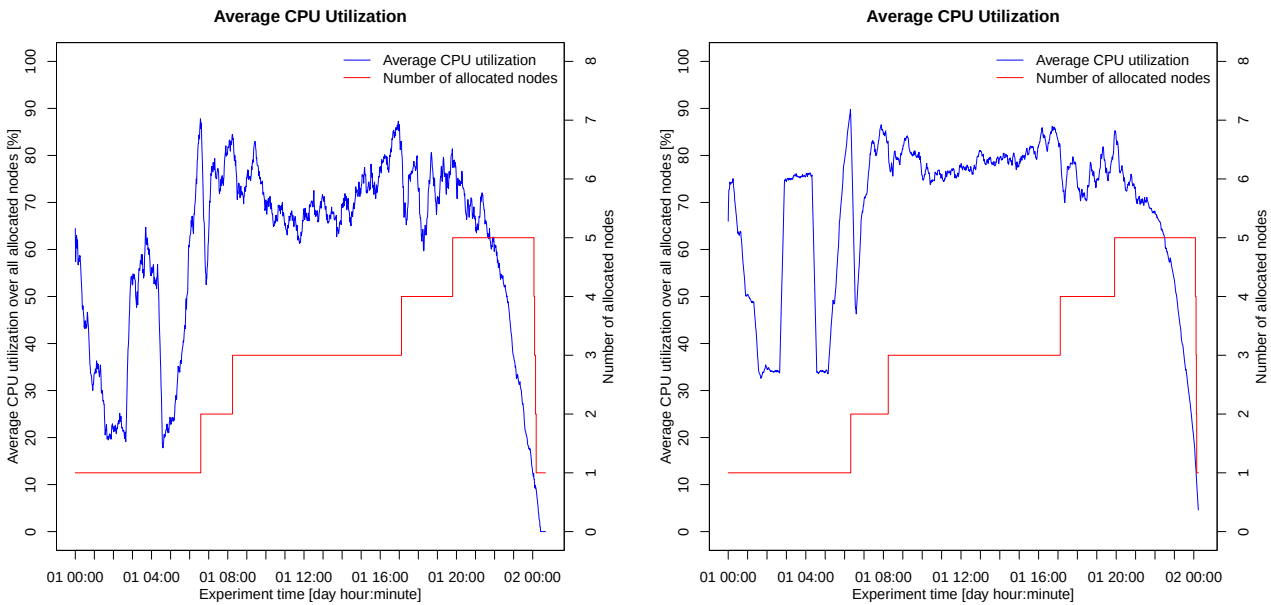
Experiment Setup

- JPetStore
- JMeter with Markov4JMeter
- Kieker [vHWH12] (monitoring framework) `kieker-monitoring.net`
- Amazon EC2 with *m1.small*
- Quantifying the relative error (RE) by comparing simulated values with measured values from Amazon EC2

Workload


Workload Intensity
Method call rate
Method call rate [number of method calls/min]
0.0
589.1
1767.3
2945.5
4123.7
5301.9
01 00:00
01 04:00
01 08:00
01 12:00
01 16:00
01 20:00
02 00:00
Experiment time [day hour:minute]

Case Study



(a) Measured CPU utilization (b) Simulated CPU utilization

Figure 2 : Average CPU utilization of allocated nodes

$RE_{CPU} = 30.64\ \%$ $RE_{InstanceCount} = 1.32\ \%$

$RE_{Costs} = 5.63\ \%$ $RE_{RT} = 37.57\ \%$

Related Work

- CloudSim alternatives: (all no cloud user perspective)
  - GroudSim [OPPF10] (not under active development)
  - MDCSim [LSN+09] (multi-tier data center simulation)
  - GreenCloud [KBK10] (energy consumption)
- iCanCloud [NCVP+11] (cloud tool with manual application modelling)

Future Work

- Framework for parallelizing simulations
- Simulate further properties, e.g., memory consumption and I/O performance
- Use CDOSim for a simulation-based evolutionary optimization of CDOs

Conclusions

- CDOSim enhances CloudSim by cloud user perspective
- CDOSim helps assessing CDO candidates and finding best suited CDO
- Simulation results can be used to appropriately predict costs, response times, and SLA violations of specific CDOs
- CDOSim is provided as part of our tool CloudMIG Xpress

CloudMIG Xpress

http://www.cloudmig.org

Measuring RE

$$re(t) = \frac{|m(t) - s(t)|}{m(t)}, \; m(t) \neq 0, \; t \in T$$

$$RE = \frac{\Sigma_t \; re(t)}{|T|}$$

$$OverallRE = \frac{RE_{CPU} + RE_{InstanceCount} + RE_{Costs} + RE_{RT}}{4}$$

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