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PALUNO
The Ruhr Institute for Software Technology

Institut für Informatik und Wirtschaftsinformatik (ICB)
Software Systems Engineering
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Title

Bachelorthesis

submitted to the faculty of economics
of the University Duisburg-Essen (Campus Essen) by

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Abstract

tbd

Zusammenfassung

tbd

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List of abbreviations

AOP Aspect-Oriented-Programming

BPEL Business Process Execution Language

CEP Complex-Event-Processing

CP Constraint Program

CSP Constraint Satisfaction Problem

CVL Common Variability Language

DSPL Dynamische Software Produktlinie

ECA Event-Condition-Action

EMF Eclipse Modelling Framework

FM Feature-Model

GQM Goal Question Metric

IaaS Infrastructure as a Service

MAPE Monitor, Analyse, Plan, Execute

OVM Orthogonal Variability Model

PaaS Platform as a Service

QoS Quality of Service

RE Requirements Engineering

SaaS Software as a Service

SE Software Engineering

SLA Service Level Agreement

SOA Service-Oriented Architecture

SPLE Software Product Line Engineering

UML Unified Modeling Language

VM Virtuelle Maschine

1. Introduction

1.1. Motivation

tbd

1.2. Goals of thesis

tbd

Zur Erreichung des Hauptziels der Arbeit werden folgende Teilziele definiert:

- **Teilziel 1:** tbd
- **Teilziel 2:** tbd
- **Teilziel 3:** tbd
- **Teilziel 4:** tbd

1.3. Vorgehensweise

Adressierung von Teilziel 1

tbd

Adressierung von Teilziel 2

tbd

Adressierung von Teilziel 3

tbd

Adressierung von Teilziel 4

tbd

2. Theoretical Foundation

2.1. Cloud Service Models

Cloud computing in general can be defined as a service for on-demand delivery of hosted services. Looking at scientific articles in this research field many definitions can be found since some researchers define it based on the associated key components and others by its benefits. Therefore, this paper uses the most cited definition provided by the National Institute of Standards and Technology (NIST) of cloud computing as following: "cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

Basically offered services of cloud computing providers are based on three fundamental models.

Software-as-a-Service In the service model "Software-as-a-Service" (SaaS) the application is hosted on a remote data center and provided to the customer over the Internet. A widely known example for SaaS is WordPress or SugarCRM. In this model the provider is responsible for software development, maintenance and required updates of the application. Another part of the responsibility of the provider is the support and maintenance of the data center (Eisa et al.).

Infrastructure-as-a-Service In the service model "Infrastructure-as-a-Service" (IaaS) the provider provides the customer with raw infrastructure over the Internet and accessible through Web Services. Provided services include processing power, storage, networks or virtual machines. The provider takes the responsibility to manage the provided infrastructure while the customer controls the operating systems, applications and programming frameworks running on the cloud. A central aspect of IaaS is the option to build a virtual data center (Zhang et al. 2010).

Platform-as-a-Service The service model "Platform-as-a-Service" (PaaS) provides the runtime and development environment. The services of this model are directed especially towards developer where the deployment of the application is performed in runtime environments which are decoupled from the corresponding programming environment (NIST). PaaS offers companies the possibility to control databases with high workload.

2.2. Allocation problem

- VM allocation problem one of the core challenges of using the cloud computing paradigm efficiently depending on cloud computing setup allocation problem varies
- Two dimensions of cloud computing scenarios
- 1st dimension: nature of offered service differentiating between IaaS, PaaS and SaaS
- 2nd dimension: focus whether service is provisioned in-house (private) or public or combination of two (hybrid)
- Other classification of cloud computing focuses on service deployment scenarios
- Assumption: service provider (SP) deploys a service on the infrastructure provided by one or more infrastructure providers (IP)
- Statement: in each scenario there is need to optimize allocation of VMs to physical resources optimization may be performed by different actors and might have different characteristics depending on exact setup
- Based on Li et al. classification VM allocation problem occurs as following:
- Public cloud: IP must optimize utilization of resources to find best balance between conflicting requirements
- Private: same optimization problem occurs for provider that act as SP and IP
- Bursted:
- IP must sole same kind of optimization as above
- SP must solve similar problem for own resources extended by possibility to off-load some VMs to external IP
- Federated: IP must solve optimization problem similar to SP
- Multicloud:
- IP must solve same optimization problem as in public cloud
- SP must solve optimization problem where optimal allocation of parts of service to IP is defined
- Cloud broker: same as multicloud scenario where broker owns role of SP
- Assumption: cloud provider (CP) must allocate VMs to a set of available resources resources either belong to CP or rented from external cloud providers (eCP)

2.3. CloudSim

CloudSim is an extensible simulation framework proposed by Calheiros et al. as a solution to overcome the challenges in regard to the evaluation of the performance of cloud provisioning policies, application workload models and resources performance models under changing system and user configurations [1]. The core focus of the toolkit is to enable "seamless modeling, simulation, and experimentation of emerging Cloud computing infrastructures and application services" [1].

2.3.1. CloudSim architecture

Figure 2.1 shows the multi-layered architecture of CloudSim Figure 2.1.

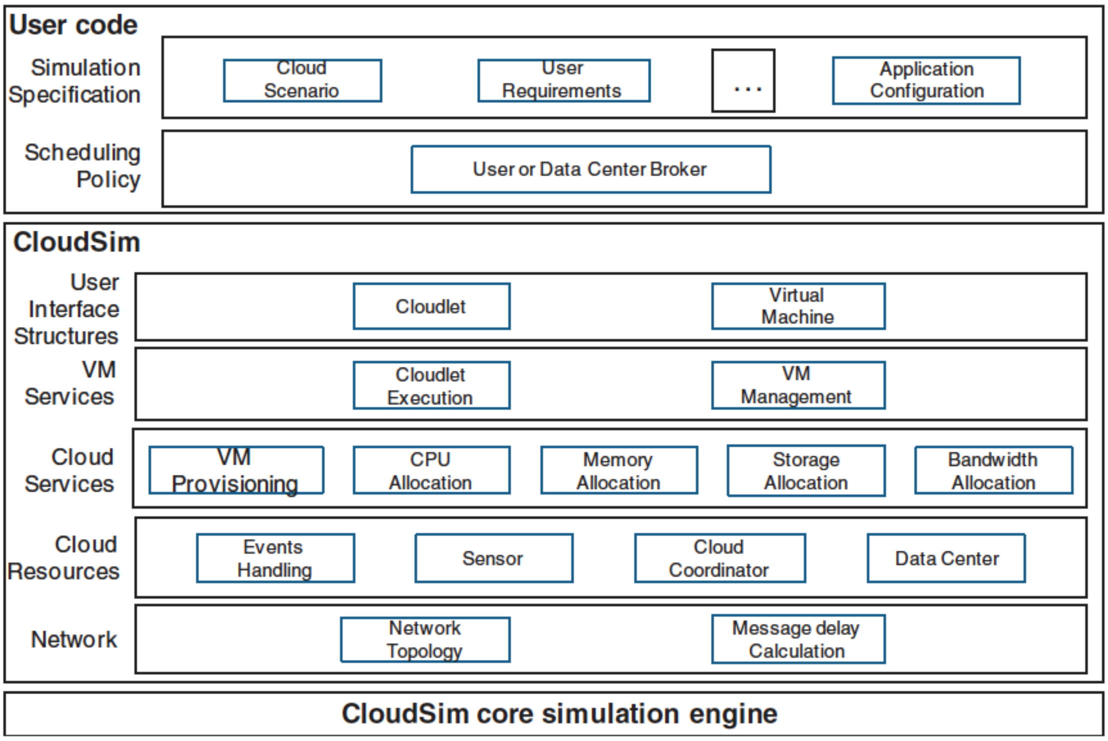

Figure 2.1.: **CloudSim Architecture**

- **User code layer:**exposes basic entities for hosts (e.g. number of machines, specification etc), applications, VMs and number of users -> enables to generate workload request distributions, application configurations, model Cloud availability, scenarios and perform robust tests –> directly available to end-users

- **User-level middleware(SaaS):** includes software framework like Web 2.0 Interfaces -> helps developers to create cost-effective user-interfaces

- **Core middleware(PaaS):** implements platform-level services to provide run-time environment for hosting and managing User-level application services

- **System Level(IaaS):** contains physical resources to power data centers
- **Simulation layer:** provides support for modeling and simulation of virtualized Cloud-based data center environments -> handling of provisioning of hosts to VMs, managing application execution and monitoring of dynamic system state

Figure 2.2.

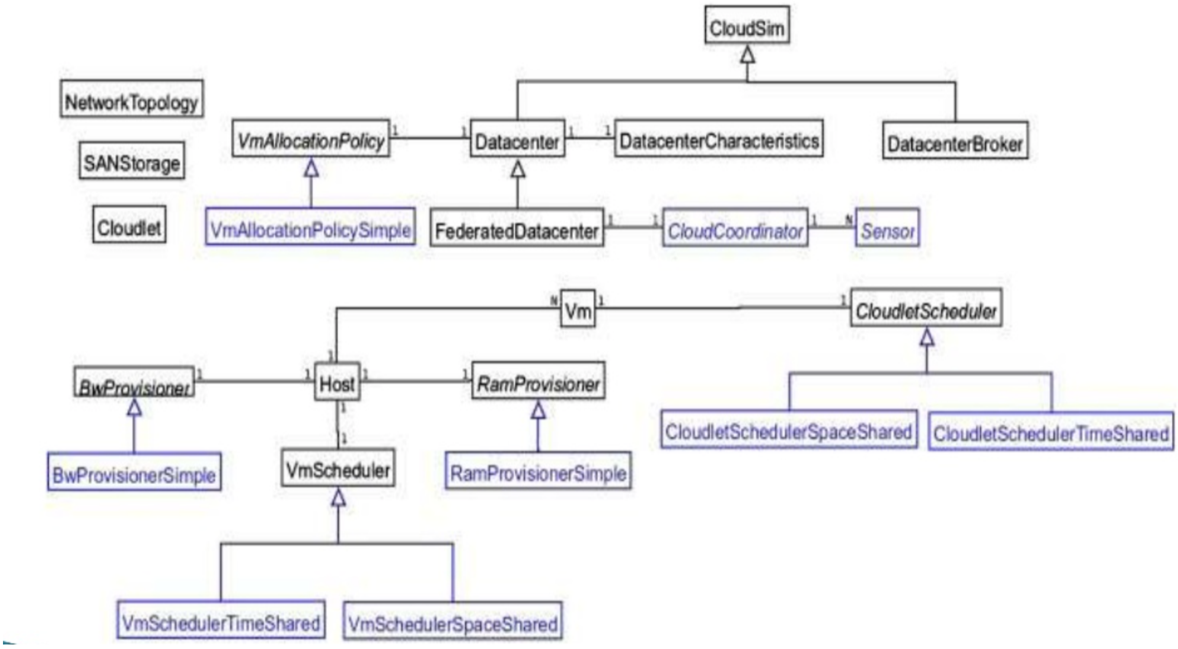

Figure 2.2.: **CloudSim Class Design**

2.3.2. Advantages

- **IT companies:** allows to test their services in repeatable and controllable environment
- allows to tune system bottlenecks before deplyoying on real cloud
- enables to experiment with different workload

3. Test X

Test der Abkürzungen.
Dynamische Software Produktlinie (DSPL)
BPEL
Monitor, Analyse, Plan, Execute

3.1. Test Figure

Eine beispielhafte Vektorgrafik ist in Figure 3.1 zu sehen.

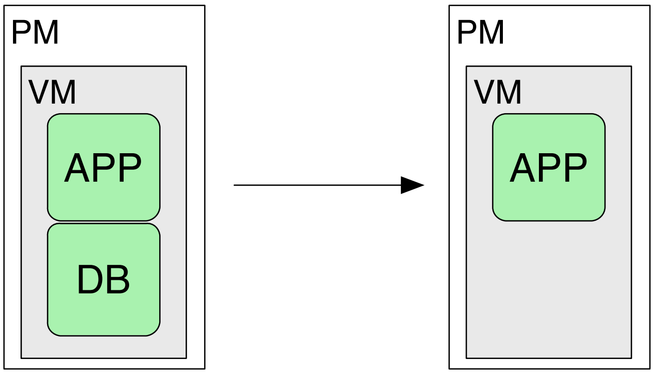

Figure 3.1.: **Test Figure**

Für XYZ siehe Tabelle 3.1.

Table 3.1.: **Test 1**

XYZ	**ABC**
ABC	DEF

3.2. Test Referenz

Beispiel siehe Marquezan et al. [2].

4. Zusammenfassung und Ausblick

4.1. Zusammenfassung

tbd

4.2. Ausblick

tbd

5. Bibliography

[1] Rodrigo N. Calheiros, Rajiv Ranjan, Anton Beloglazov, CÃ©sar A. F. De Rose, and Rajkumar Buyya. “CloudSim: A Toolkit for Modeling and Simulation of Cloud Computing Environments and Evaluation of Resource Provisioning Algorithms”. In: *Softw. Pract. Exper.* 41.1 (Jan. 2011), pp. 23–50.

[2] Clarissa Cassales Marquezan, Florian Wessling, Andreas Metzger, Klaus Pohl, Chris Woods, and Karl Wallbom. “Towards exploiting the full adaptation potential of cloud applications”. In: *Proceedings of the 6th International Workshop on Principles of Engineering Service-Oriented and Cloud Systems, PESOS 2014, Hyderabad, India, May 31, 2014*. Ed. by Muhammad Ali Babar, Hye-Young Paik, Malolan Chetlur, and Michael Bauer. ACM, 2014, pp. 48–57.

Appendix

A. Anhang

A.1. tbd

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Eidesstattliche Erklärung

Hiermit versichere ich, dass ich die vorliegende Arbeit ohne Hilfe Dritter und nur mit den angegebenen Quellen und Hilfsmitteln angefertigt habe. Ich habe alle Stellen, die ich aus den Quellen wörtlich oder inhaltlich entnommen habe, als solche kenntlich gemacht. Diese Arbeit hat in gleicher oder ähnlicher Form noch keiner Prüfungsbehörde vorgelegen.

Essen, den March 17, 2017