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Chapter 1

Cloud computing and Model-Driven Artchitecture

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1.1 Cloud computing

Cloud computing is gaining popularity and more companies are starting to explore the possibilities as well as the limitation to the cloud.

Some of the most essential characteristics of cloud computing [3] are:

- *On-demand self-service*: Consumers can do provisioning without any human interaction
- *Broad network access*: Capabilities available over standard network mechanisms
- *Resource pooling*: Physical and virtual resources are dynamically assigned and reassigned according to consumer demand
- *Rapid elasticity*: Automatic capability scaling
- *Measured service*: Monitoring and control of resource usages

Provider	**Service**	**Service Model**
AWS	Elastic Compute Cloud	IaaS
AWS	Elastic Beanstalk	PaaS
Google	Google App Engine	PaaS
CA	AppLogic	IaaS
Microsoft	Azure	PaaS and IaaS
Heroku	Different services	PaaS
Nodejitsu	Node.js	PaaS
Rackspace	CloudServers	IaaS

Table 1.1: Common providers available services

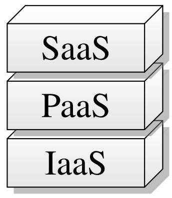

Figure 1.1: Cloud architecture service models

There are three main architectural service models in cloud computing [3] namely *Infrastructure-as-a-Service* (IaaS), *Platform-as-a-Service* (PaaS) and *Software-as-a-Service* (SaaS). IaaS is on the lowest vertical integration level closest to physical hardware and SaaS on the highest level as runnable applications. Stanoevska-Slabeva [5] emphasizes that *"infrastructure had been available as a service for quite some time"* and this *"has been referred to as utility computing"*, such as Sun Grid Compute Utility.

IaaS. The main providers are Google, Amazon with *Amazon Web Service* (AWS) [1] and Microsoft. A non-exhaustive list of common providers are visualized in TABLE. 1.1. The *National Institute of Standards and Technology* (NIST) is one of the leaders in cloud computing standardization. The NIST Definition of Cloud Computing [3] define IaaS as

> The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications.
>
> NIST, 2011

These are capabilities found in cloud provider services, such as AWS *Elastic Compute Cloud* (EC2) and Rackspace CloudServers. NIST continue to state that

> The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (*e.g.*, host firewalls).
>
> NIST, 2011

PaaS. The PaaS model is defined as an capability consumers use to deploy applications onto cloud infrastructure that provide fully partially support. For this kind of deployment consumers do not have to manage or control underlying infrastructure capabilities, and in some cases not even configuration. Examples of PaaS providers are Google with *Google App Engine* (GAE) and the company Heroku with their service with the same name. Multiple PaaS providers utilize EC2 as underlying infrastructure, examples of such providers are Heroku Nodester and Nodejitsu, this is a tendency with increasing popularity.

SaaS. The core purpose is to provide whole web applications as services, in many cases end products. Google products such as gmail, Google Apps and Google Calendar are examples of SaaS applications.

There are four different deployment models according to The NIST Definition of Cloud Computing [3]:

- *Private cloud*: Similar to classical infrastructures where hardware and drifting is owned and controlled by organizations themselves.
- *Community cloud*: When several organizations share the same aspects of a private cloud (such as security requirements, policies, and compliance considerations), and therefore share infrastructure.
- *Public cloud*: Infrastructure is open to the public. Cloud providers own the hardware and rent out IaaS and PaaS solutions to users. Examples of such providers are Amazon with AWS and Google with GAE.
- *Hybrid cloud*: Combining private cloud or community cloud with public cloud. One benefit is to distinguish data from logic for purposes such as security issues, by storing sensitive information in a private cloud while computing with public cloud.

Beside these models defined by NIST there is another arising model known as *virtual private cloud*, which is similar to *public cloud* but with some security implications such as sandboxed network.

1.2 Model-Driven Architecture approach

By combining the world of cloud computing with the one of modeling it is possible to achieve benefits such as improved communication when designing a system and better understanding of the system itself. This statement is emphasized by Booch *et al.* in one of his studies:

> “Modeling is a central part of all the activities that lead up to the deployment of good software. We build models to communicate the desired structure and behavior of our system. We build models to visualize and control the system’s architecture. We build models to better understand the system we are building, often exposing opportunities for simplification and reuse. We build models to manage risk.”
>
> Booch, 2005

When it comes to cloud computing these definitions are even more important because of financial aspects since provisioned nodes instantly draw credit. The definition of “modeling” can be assessed from the previous epigraph, but it is also important to choose correct models for the task. Stanoevska-Slabeva emphasizes in one of her studies that grid computing “*is the starting point and basis for Cloud Computing.*” [5]. As grid computing bear similarities towards cloud computing in terms of vitalization and utility computing it is possible to use the same UML diagrams for IaaS as previously used in grid computing. The importance of this re-usability of models is based on the origination of grid computing, *eScience*, and the popularity of modeling in this research area. The importance of choosing correct models is emphasized by Booch [2]:

> *(i)*The choice of what models to create has a profound influence on how a problem is attacked and how a solution is shaped. *(ii)*Every model may be expressed at different levels of precision. *(iii)*The best models are connected to reality. *(iv)*No single model is sufficient. Every nontrivial system is best approached through a small set of nearly independent models.
>
> Booch, 2005

These definition precepts state that several models (precept *(iv)*) on different levels (precept *(ii)*) of precision should be used to model the same system. From this it is concludable that several models can be used to describe one or several cloud computing perspectives. Nor are there any restraints to only use UML diagrams or even models at all. As an example AWS CloudFormation implements a lexical model of their *cloud services*, while CA AppLogic has a visual and more UML component-based diagram of their capabilities.

Model-Driven Architexture. When working with *Model-Driven Architecture* (MDA) it is common to first create a *Computation Independent Model* (CIM), then a *Platform-Independent Model* (PIM) and lastly a *Platform-Specific Model* (PSM). There are other models and steps in between these, but they render the essentials. There are five different life cycles as explained by Singh [4]:

1. Create a CIM capturing requirements.
2. Develop a PIM.
3. Convert the PIM into PSM.
4. Generate code form PSM.
5. Deploy.

Bibliography

[1] Amazon. Amazon web services, 2012.

[2] Grady Booch, James Rumbaugh, and Ivar Jacobson. *Unified Modeling Language User Guide, The (2nd Edition) (Addison-Wesley Object Technology Series)*. Addison-Wesley Professional, 2005.

[3] Peter Mell and Timothy Grance. The NIST Definition of Cloud Computing Recommendations of the National Institute of Standards and Technology. *Nist Special Publication*, 145(6):7, 2011.

[4] Y. Singh and M. Sood. Model Driven Architecture: A Perspective. In *Advance Computing Conference, 2009. IACC 2009. IEEE International*, pages 1644 – 1652, march 2009.

[5] Katarina Stanoevska-Slabeva and Thomas Wozniak. Cloud Basics - An Introduction to Cloud Computing. In Katarina Stanoevska-Slabeva, Thomas Wozniak, and Santi Ristol, editors, *Grid and Cloud Computing*, pages 47–61. Springer Berlin Heidelberg.