The Project Cloud4E – Cloud Solutions for Engineers

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1 Introduction

Advances and innovations in the field of engineering are key factors to sustain and strengthen the success and recognition of Germany's leading role in industry worldwide. Small and medium-sized enterprises are of particular importance in this context. Today, the development of innovative and reliable products is often enabled and facilitated by the use of Computer Aided Engineering (CAE) methods. The most essential part of CAE are computer based simulations that often require a tremendous amount of hardware resources along with the expertise for its setup and administration. Thus, especially for small and medium-sized enterprises, cloud technology can provide an opportunity to use reliable state-of-the-art computing resources without the need for any in-advance investments in hardware, software and personnel. However, such enterprises are often not willing or allowed to process sensitive data on resources of large and anonymous cloud providers. This yields a large market potential for smaller data centers operating on a local basis guaranteeing the processing and storage of data within German jurisdiction as well as providing personal feedback and support.

In the project *Cloud4E* – Trusted Cloud Computing for Engineering – a local data center, the GWDG from Göttingen, a simulation software provider, ITI from Dresden, and a medium-sized engineering enterprise, ERAS from Göttingen, cooperate with two research institutes, the Fraunhofer EAS (a branch of Fraunhofer IIS) from Dresden and the University of Erlangen-Nuremberg (FAU), in order to define and implement a software stack that enables an easy porting of existing simulation software to a cloud service.

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The intend is to facilitate the transition for simulation software providers from conventional local on-site software provisioning models towards software-as-a-service (SaaS) solutions. In the increasingly cloud based environment this will bring benefits to both, software providers as well as end users. The deployment of software in form of a cloud service is enabled by our development environment, which provides well-defined interfaces. Finally, the end user is able to use the service in order to execute simulations in the cloud on as many virtual machines as necessary and on a pay-per-use basis. Furthermore, the user is able to constantly query the status and progress of ongoing simulations.

By using the Cloud4E infrastructure a simulation software provider is able to make its CAE tools available to users that were previously not able to use the tool due to cost reasons. In particular, CAE tools in form of cloud services provide the following advantages to a user:

- The one-time-only usage of a simulation software, e.g., in a certain project, becomes affordable.
- It is not required to operate an extra infrastructure for a tool that is used only occasionally.
- It is ensured that the tool runs in an adequate software environment.
- Peak demands in resources, for example at the end of a project, can be satisfied without problems.
- IT personnel for the administration of soft- and hardware can be saved.

2 The Basic Infrastructure

In this section the basic layout of the Cloud4E infrastructure is described. Figure 1 illustrates all the components of the basic infrastructure. Some of which are developed in the project while others are external components.

The user is not provided access to physical resources but only to virtual machines (VMs), as usual in cloud environments. The management of VMs is done by a cloud middleware. In the project we use two freely available open source platforms, namely OpenStack [1] and OpenNebula [2], which besides the management of VMs, also provide means for other tasks like user management. All services that are developed in Cloud4E aim to be as independent as possible from a particular cloud middleware, which is facilitated by testing the services with two different middlewares (OpenStack and OpenNebula).

The simulations of a Cloud4E user are running inside VMs (denoted as Service Node(s) in Figure 1). The remote control of simulations is done via the Open Cloud Computing Interface (OCCI) [3]. OCCI is an open standard specifying an interface for the control of cloud components. The communication is based on an OCCI server, which is independent from the cloud middleware. By employing such an open standardized interface, vendor lock-ins are avoided. Providers of cloud based simulation services do not have to deal with OCCI details, because they are provided with a tool called *OCCI Service Adapter*. This component is the core of the

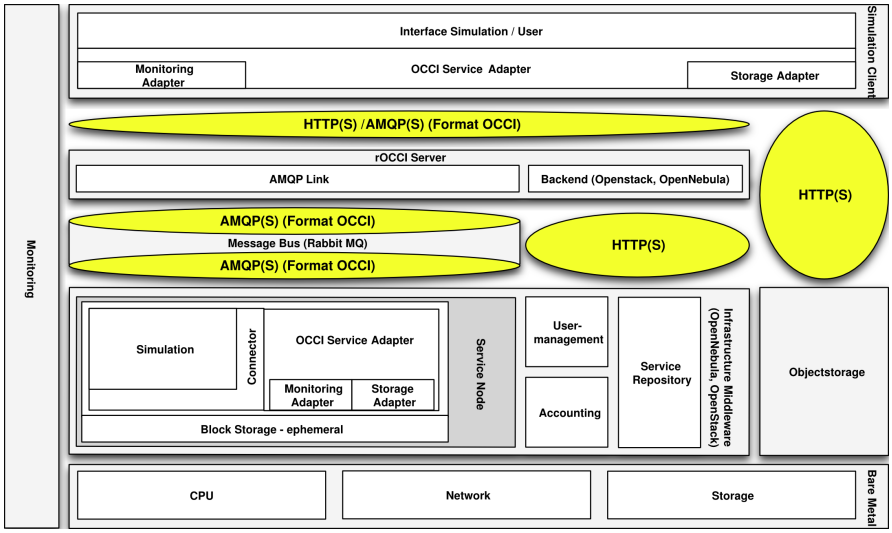

Fig. 1 The basic Cloud4E infrastructure.

Cloud4E infrastructure and is developed within the project; it provides the OCCI interface to simulation tools, is generic and does not have to be adapted by the software service provider. Instead, all functionality specific to a simulation service is implemented by its provider in form of methods in a so called connector, which is the link between the simulation service and the OCCI Service Adapter. It implements the functionality underlying the simulation service specific parts of the OCCI interface, e.g., the start or stop of a simulation. For the implementation of the connector simulation software providers can make use of a library contained in the OCCI Service Adapter, which provides functionality typically required for controlling and monitoring a simulation service.

The simulations in a VM can access a block storage, which is used to provide the input data to the simulations and to deliver output data back to the end user. All data in the block storage is stored persistently within the cloud infrastructure, either in an object store or in a POSIX conform file system. For the OCCI communication, both AMQP(S) and HTTP(S) can be used, where in the project, AMQP is the preferred transport protocol as it provides more functionality than HTTP. RabbitMQ [4] is used as AMQP server in Cloud4E. The OCCI Service Adapter is also used for the end users interface to the system in order to monitor and control simulations. With help of the library of the OCCI Service Adapter generic command line and graphical clients are provided.

This library can also be used by software providers in order to tailor specific clients for their respective CAE tools or integrate the client functionality in their existing software.

The monitoring of simulations is done with help of a suitable tool like logstash [5].

3 Conclusion

In the project Cloud4E, interfaces are developed which allow vendors of CAE software to provide their software as software-as-a-service in the cloud. These interfaces take as much work as possible out of the software provider's hands, such that the provider does not have to deal with the details of cloud technology. Instead, only the specific functionality for the control of the software in form of a so called connector has to be implemented. For the software client, used by the end user, the software provider can make use of generic solutions which can be extended and adapted to any particular needs. As Cloud4E is not restricted to a specific cloud platform and makes use of open standards and interfaces, such as OCCI and AMQP, it permits a high portability of services and avoids vendor lock-in.

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