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Towards an adaptive civil engineering computation framework

Michael Polter, Raimar Scherer *

Technische Universität Dresden, Institute of Construction Informatics, Nuernberger Str. 31a, 01062 Dresden, Germany

Abstract

Virtual desktops and virtual applications nowadays become popular in civil engineering companies. Current developments of software vendors trend to the outsourcing of the engineer's workstation to the cloud. However, in the foreseeable future companies will rely on hybrid environments where traditional tasks are handled by traditional applications and cloud platforms are used for more dynamical business areas. Furthermore, stakeholders in construction projects are geographically spread and work together only temporary. Traditional applications never were designed for this scenario. In this paper we introduce the *BIMgrid*, a work in progress to develop an innovative, adaptive infrastructure integration framework for civil engineering applications, based on private grid and public cloud resources. Although some middleware solutions for the efficient combination of hardware already exist, they are mostly based on UNIX and demand advanced technological knowledge to implement.

We present our current state of work and give an overview about the architecture of the BIMgrid, the integration into an IT infrastructure, data management and the interfaces to use it's features with common applications. The prototype implementation is designed as a layered, service-oriented architecture (SOA) and offers several interfaces. Data Management in the BIMgrid will be based on vendor specific data formats and the Industry Foundation Classes (IFC) standard and hence supports the interoperability between applications. Our prototype has been developed in several research projects and tested by industry partners under real conditions.

We expect to reduce costs of small and medium-sized enterprises (SMEs) through the automation of complex workflows, optimization of data transfer and reduction of the communication effort between stakeholders. Further we want to make benefits of grid and cloud computing accessible to companies, without dissipation of so far made hard- and software investments.

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Keywords: "bim; cloud; grid; integration platform; soa"

* Michael Polter. Tel.: +49-351-46342539.
E-mail address: Michael.Polter@tu-dresden.de

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1. Introduction

Today, in civil engineering companies engineers are faced with lots of different computation and collaboration tools as well as database implementations, which in combination are utilized to solve complex tasks from different domains. Often this involves much effort in data management, especially in scenarios where collaboration with external partners results in multiple iteration loops with repeated data exchange. Although some integration solutions for coupling of multiple tools emerge, which support users in handling of complex workflows, they generally lack flexibility regarding to the established practices in companies. Usually, engineers are bound to the tools of the platform vendor and if they don't provide a specific feature or exceed the capabilities of the local machine, a manual switch between applications is again inevitable. Following the hype of cloud computing, big vendors increasingly offer integrated solutions, which completely outsource the engineer's workstation to the cloud. However, these pay per use products don't consider the so far made investments of companies in hard- and software, tend to cause unforeseeable running costs and in addition come along with problems in data security and privacy. Today, SMEs usually own a powerful hardware infrastructure that often is only used to 5% of its capacity [1]. This arises from the lack of solutions for an effective combined usage of the resources. Existing middlewares for the connection of local machines to a private grid generally are limited to UNIX-based networks, rarely offer a graphical user interface and hence are inappropriate for a direct application in engineering companies.

The development of software solutions from the scratch, which address all the aforementioned problems, in general exceeds the financial capabilities of SMEs. The BIMgrid provides a framework as well as a core implementation, which can be utilized by application and web developers to implement a platform (or to enhance existing applications), customized to the specific needs and practices of a civil engineering company. Therefore, our concept provides interfaces to transparently integrate tools and technologies from different functional domains like computation, data management, workflow scheduling or computation infrastructure. The overall objective is to support companies in the automation of complex workflows, the connection of vendor-specific data artifacts with IFC models, their organization in projects and the provision of a shared platform to ease the exchange of data with external project partners

This paper is structured as follows. In the subsequent section, we take a look at the current state of integration platforms and other related work. In section 3, we present selected parts of our framework and the core implementation with scope on the interface architecture. Section 4 finally concludes the paper and gives an outlook on future work.

2. Related Work

Although some platforms for the integration of third-party tools already exist, they are mainly focused on a single aspect like the coupling of solvers or the deployment on different hardware infrastructure. The ONELAB (Open Numerical Engineering LABoratory) [2] implements an open source interface toolkit for the integration of various tools like mesh generators and numerical solvers. This allows the execution of workflows involving different tools under a uniform user interface. The ONELAB allows the integration of distributed computers through TCP/IP socket communication but, in contrast to our approach, does neither provide an intelligent workflow orchestration nor integrated data management.

The ANSYS workbench[1] is a commercial platform for the integration of solvers and CAD (computer aided design) software as well as the management of the corresponding models. It supports change propagation, the import of models from popular CAD vendors and script-based workflow automatization. Though ANSYS provides a cloud migrated version of some tools, the original workbench is tied to a single workstation, provides no on-demand access to distributed resources and hence is limited to sequential workflow processing. The integration of grid and on-demand extension with cloud resources make the BIMgrid more flexible and allows the parallel workflow execution.

[1] http://www.cadfem.de/produkte/ansys/ansys-workbench.html