Paper 12

Proceedings of the Eighth International Conference
on Engineering Computational Technology,
B.H.V. Topping, (Editor),
Civil-Comp Press, Stirlingshire, Scotland

Platform as a Service Computing Environment for Earthquake Engineering

M. Dolenc and R. Klinc
Faculty of Civil and Geodetic Engineering
University of Ljubljana, Slovenia

Abstract

The domain of civil engineering is usually not considered as a domain in which high-performance or high-throughput computing is required on a daily basis. But new innovative methods based on the nonlinear static or dynamic analyses could change this very soon.

To enable civil engineers in general and earthquake engineers in particular for research and development of new and innovative analyses methods a novel cloud platform has been developed. The developed cloud platform prototype provide computational resources via a platform upon which applications and services can be developed and hosted. It is conceptually based on cloud computing technologies and enables different end-user scenarios - from earthquake engineering end-user use case to service or application development for the computing environment.

The paper provides an overview of the cloud platform developed as well as brief descriptions and discussion of the underlying technologies used in the development.

Keywords: cloud computing, platform as a service, software as a service, high-throughput computing, earthquake engineering, ICE4RISK.

1 Introduction

Cloud computing [1] [2] is a type of computing in which IT-related capabilities are provided "as a service", allowing users to access technology-enabled services from the Internet without knowledge of, expertise with, or control over the technology infrastructure that supports them. It provides the means through which everything from computing power to computing infrastructure, applications, business processes to personal collaboration can be delivered to you as a service wherever and whenever you need. One of the most immediate benefits of cloud-based infrastructure services is the ability to add new infrastructure resources quickly and at lower costs. This allow the business to gain IT resources just-in-time, thus saving time and money. A typical cloud service provider has economies of scale that the typical corporation lacks - this is of course even more true for SMEs. With the advent of the cloud, an organisation can try out a new application or develop a new application without first investing in hardware, software, and networking. Another advantage of using cloud based services is to access data and applications at any place, from any device and at any time. This is becoming more and more important with the trend of more workers telecommuting from home, and more freelancers and consultants competing for jobs all over the place. Using applications as a service also has the benefit of being always up-to-date as most cloud based application services providers constantly update their software offerings, adding new features as they become available.

The goal of the ICE4RSIK project (High-throughput computing environment for seismic risk assessment) [3] was the development of the dynamically upgradeable high-throughput computing environment for seismic risk assessment of buildings and urban areas and development of the new or upgrade of the existing software for probabilistic seismic risk analysis. The developed cloud based computing environment was reported on in several conference and journal articles [4][5]. To address some of the known issues of the ICE4RISK computing environment it was extended with features of a full cloud platform supporting complete life cycle of building, delivering and managing web applications for seismic risk assessment.

The paper provides an overview of the developed cloud platform computing environment as well as brief descriptions and discussion of the underlying technologies used in the development of the computing environment.

2 ICE4RISK cloud platform

The goal of the ICE4RISK project was to develop a user-friendly computing environment that would enable researchers as well as practitioners to adopt innovative methods for seismic risk assessment based on the non-linear static or dynamic analyses. The following chapters present an overview of the technologies, architecture and implementation of the developed computing environment.

2.1 Cloud platform

Cloud computing is a general concept [6] that incorporates [Software — Platform — Infrastructure] as a Service, Web 2.0 and other technology trends, in which the common theme is reliance on the Internet for satisfying the computing needs of the users. The above mentioned services provide different levels of abstractions of applications, runtime environment and hardware infrastructure for running applications [7] (see Figure 1).

Platform as a Service (PaaS) provide computational resources via a platform upon

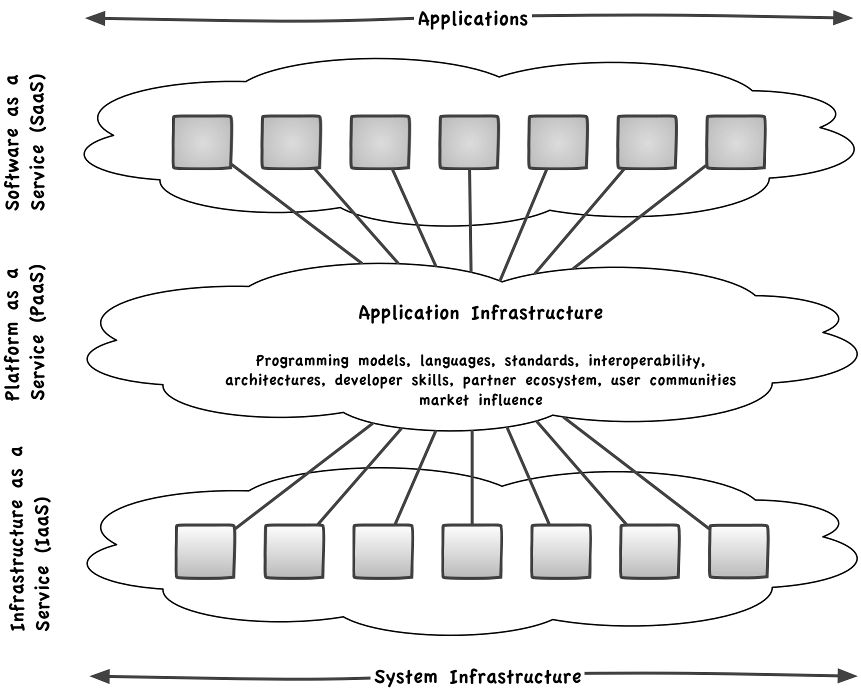

Figure 1: Platform as a Service represent the strategic center of cloud computing architecture [8].

which applications and services can be developed and hosted. PaaS typically makes use of dedicated application programming interfaces (APIs) to control the behaviour of a server hosting engine which executes and replicates the execution according to user requests. PaaS can be defined as a platform for the creation of application or software delivered over the web on demand. Considering different end-users PaaS has several benefits:

- Each platform component is provided as a service (middleware, integration, communication, etc.) - it supports complete life cycle of building and delivering web applications and services on the internet.
- By following the cloud service model it reduces Total Cost of Ownership (TCO) as there is no need to buy all the system, software, platforms, tools and kits needed to build, run and deploy the application.
- PaaS is a perfect match for agile software development methodologies and enables a rapid construction of applications in a cloud environment by providing essential domain specific services (workflow management, data management, etc.).

While the benefits of PaaS solutions are clear, there are also some adoption barriers. Primary concern is in a vendor lock-in. In vendor lock-in customers are dependent on a single vendor for some product or solutions. PaaS while requiring certain infrastructure, tools or framework to implement posses the vendor lock in situation. Hopefully future research and standardisation in the PaaS domain will help lift this concern for the potential users.

2.2 Implementation

There are several reasons to implement the computing environment end-user interface through the web application (see Figure 2). Firstly, the data sets used by researchers can contain huge amount of data and as such are not appropriate for distribution. Although anyone can create his own data storage, it is unlike that many researches or users will do so. Therefore it is most appropriate that the research data is stored and maintained in one place and can be easily accessible through the internet.

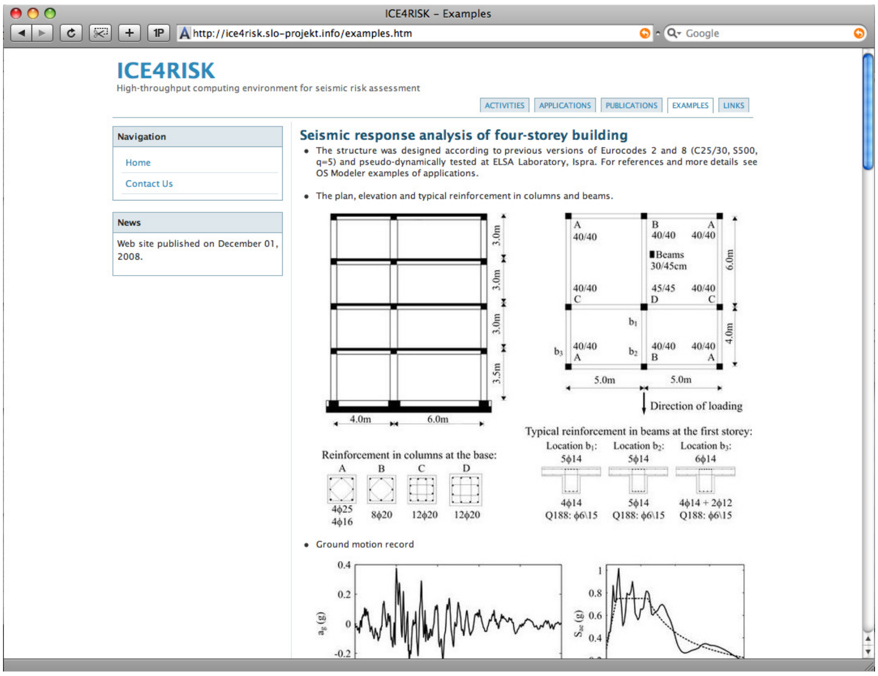

Figure 2: ICE4RISK project website with access to various cloud services. The presented service enables researchers to select relevant accelerograms based on specific criteria.

The most convenient access to the research data is through the web application, which is simply accessible and user-friendly. Advantages of such environment are operating system independence, no need for installation and no maintenance cost. In addition, web based application can be accessed from anywhere at any time, which makes it even more attractive. The web application was built following the classic three-tier client-server architecture, which enforces a general separation of three parts: client tier (also named presentation layer or, more specifically, user interface), mid-

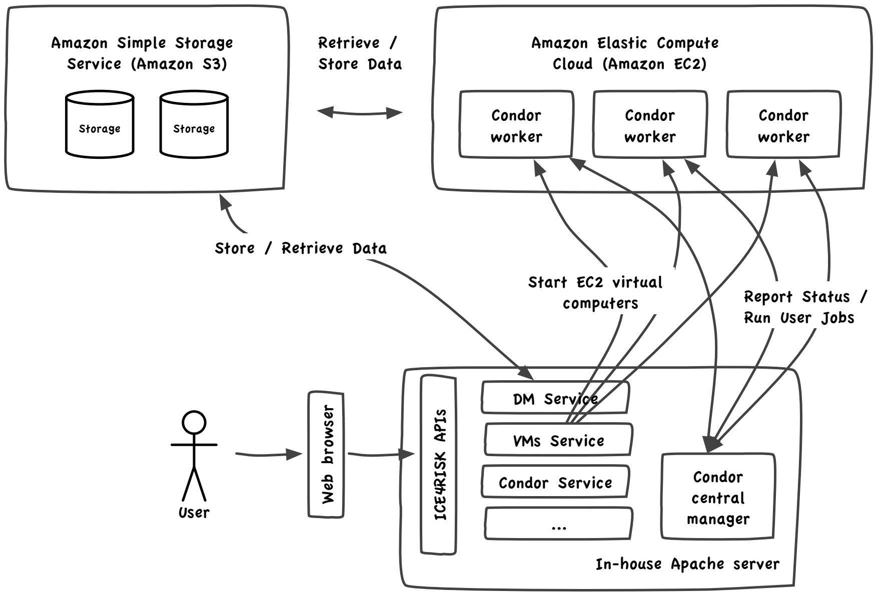

Figure 3: ICE4RISK cloud platform based resources and services. The platform prototype uses a local Apache server and several remote virtual machines.

dle tier (business logic) and data storage tier. The top-most level of the application is the user interface on the presentation tier of the system. Its main function is to translate tasks and results to something the user can understand. In our application the presentation is disseminated through a web browser which handles web pages encoded in (X)HTML language and generated by a web server on the layer of business logic. Calls between the user interface and the web server are both synchronous and asynchronous. For asynchronous calls, Ajax web programming approach was applied. The middle tier, the business logic layer is based on the Apache web server running on the Linux platform. Requests are handled by scripts written by using the PHP programming language which are processing input parameters, interacting with relational database, parsing results and preparing output (X)HTML pages.

For the underlying system architecture we adopted the PaaS model of software deployment, allowing us to develop, host, operate, maintain and upgrade software from a central location (web server) for global use. The use of specialised cloud services [9] allows for scalable deployment of applications by providing a web services interface through which researchers can request an arbitrary number of virtual machines, i.e. server instances, on which they can perform the required analyses. Figure 3 shows a basic topology of the developed ICE4RISK cloud platform. In the prototype environment, the local system resides on one server; however, the architecture is scalable so the business logic (different available services, etc.) and data layer can be distributed to different physical servers if the requirements emerge.

3 Conclusion

The prototype engineering cloud platform described has been developed based on the ICE4RISK computing environment that was extended to adopt the cloud paradigm. The platform provides several features and application programming interfaces that enable a typical engineering end-user to personalise the platform to their own needs. The platform hides the low-level details of implementation through different cloud based technologies and thus enables the end-user to focus on their research.

There are several open issues regarding the utilisation of cloud platforms including scalability, usability and economical issues. Future research and development will addressed these issues by extending the adoption of the developed ICE4RISK cloud platform by industry end-users.

While cloud computing has many benefits, many IT professionals and researchers have expressed concerns about some of the risks still associated with the concept (see Figure 4). Since the barriers are mostly related to the human and organisational factors and less to the legal and technological factors, the conclusions are clear - we need software system architectures that will address those issues instead of focusing on the technological aspect of the developed platforms.

We believe that cloud computing model, together with other related technologies and business practices, can provide the infrastructure for developing next generation engineering computing environments.

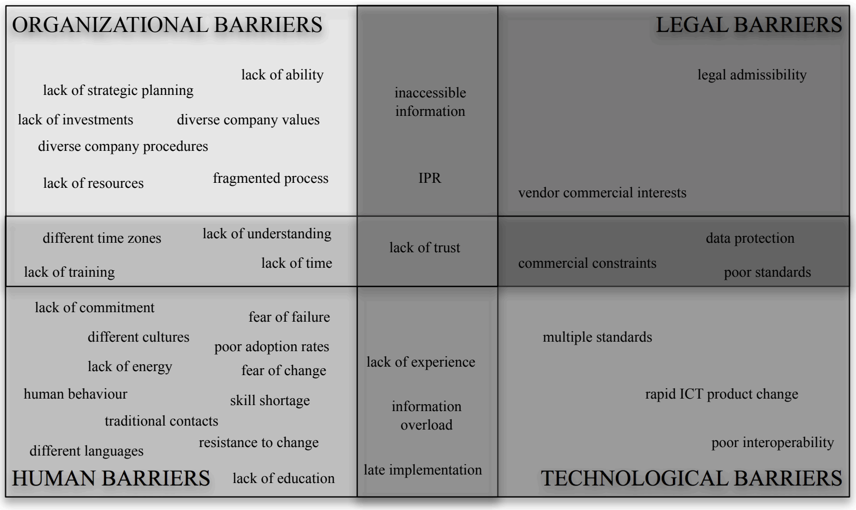

Figure 4: Four main groups of barriers for the successful adoption of the ICT in SMEs. The barriers to ICT adoption are mostly related to the human and organisational and less to the legal and technological factors.

Acknowledgement

The work presented in this paper has been partially conducted in the context of the "High-throughput computing environment for seismic risk assessment" project sponsored by the Slovenian Research Agency (http://www.arrs.gov.si/en/). Their support is acknowledged.

References

[1] C. Hewitt, "ORGs for Scalable, Robust, Privacy-Friendly Client Cloud Computing", IEEE Internet Computing, vol. 12, no. 5, pp. 96-99, Sep/Oct, 2008.

[2] P. Mell and T. Grance, "The NIST definition of Cloud Computing", http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc

[3] High-throughput computing environment for seismic risk assessment (ICE4RISK), http://ice4risk.slo-projekt.info/

[4] I. Perus, R. Klinc, M. Dolenc, M. Dolsek, "A web-based methodology for the prediction of approximate IDA curves", Earthquake eng. struct. dyn.. [Print ed.], 2012.

[5] M. Dolenc, R. Klinc, I. Perus, M. Dolsek, "The ICE4RISK Computing Environment", in B.H.V. Topping, J.M. Adam, F.J. Pallars, R. Bru, M.L. Romero, (Editors), "Proceedings of the Seventh International Conference on Engineering Computational Technology", Civil-Comp Press, Stirlingshire, UK, Paper 16, 2010. doi:10.4203/ccp.94.16

[6] D. Happell, " Short Introduction to Cloud Platforms", http://www.davidchappell.com/CloudPlatforms--Chappell.pdf, 2008.

[7] J. Keith & N.L. Burkhard, "The Future of Cloud Computing: Opportunities for European Cloud Computing Beyond 2010", http://cordis.europa.eu/fp7/ict/ssai/docs/cloud-report-final.pdf, 2010.

[8] Y. Natis, "Consider Platform as a Service (PaaS) in your Cloud Strategy", http://www.gartner.com/it/content/1525800/1525814/february_15_consider_platform_as_a_service_ynatis.pdf, 2010.

[9] Amazon Elastic Compute Cloud (Amazon EC2), http://aws.amazon.com/ec2/