Guest Editors' Introduction: Special Issue on Interoperability, Federation Frameworks and Application Programming Interfaces for IaaS Clouds

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Infrastructure as a Service (IaaS) cloud systems allow the dynamic creation, destruction and management of Virtual Machines (VM) on virtualized clusters. IaaS clouds provide a high-level of abstraction to the end user that allows the creation of on-demand services through a pay as you go infrastructure combined with elasticity. As these concepts emerged, commercial and academic infrastructure providers adopted them so rapidly that they and their end users inevitably faced and continue to face severe interoperability issues. Providers and user communities are pursuing through multiple means the goal of unification of multiple cloud and/or grid solutions in seamless, preferably interoperable ways. Hybrid, community or multi-cloud settings have also emerged that utilize more than one cloud system simultaneously, often called cloud federations. Practical management of such federations

raises several challenges and open issues that require significant research and development.

This special issue on interoperability, federation frameworks and Application Programmer Interfaces (APIs) for IaaS clouds was aimed at bringing together a variety of solutions from large commercial cloud providers, standards organizations, multi-user/multi-organization infrastructure providers and users to provide formal descriptions of their existing or proposed solutions. The goals of this issue are to help the community document the current state, determine future goals, and present current and emerging architectures and service frameworks that help to achieve highly interoperable cloud infrastructures, and to do so with papers that illustrate the best available practices and research work.

To obtain the best possible results, all submissions were evaluated through a rigorous selection and reviewing process. The Call for Papers for the special issue was launched in autumn 2012. Upon reaching the submission deadline, we received 20 submissions that were of good quality and generally relevant to the theme of the special issue. These papers were reviewed both by experts in the field and by the guest editors through a procedure that guaranteed that each paper received at least 4 independent high-quality reviews. After this initial selection process, the papers were sent to the authors for one or multiple further revision rounds. Finally, we selected the 6 strongest resulting papers, giving an overall 30 % acceptance rate.

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The selected papers presented here represent three major research areas: (i) low level interoperability issues and applications of IaaS systems, (ii) architectures and APIs to hide the complexity and interoperability issues amongst the various infrastructure providers, (iii) standardization issues related to task management in clouds. The rest of this editorial provides a short overview on the included papers in relation to these major research areas.

The first two papers deal with low level interoperability issues in IaaS systems. They identify that current IaaS systems often lack even basic functionalities when end users try to cross cloud boundaries. This special issue focuses on mainly two of these basic functionalities. First, in the paper titled “*Adding Federated Identity Management to OpenStack*”, D. W. Chadwick et al. reveals that end users face cross cloud issues even in homogeneous cloud federations that use a single kind of cloudware (like OpenStack). In this paper, they show an approach with which an OpenStack powered could make use of already existing federated identity management solutions on an efficient and extensible way. Next, in the article called “*The EMI Registry: Discovering Services In A Federated World*”, L. Field et al. present the issues with current service discovery mechanisms in the context of federations of distributed computing infrastructures. To resolve these issues, they introduce a new distributed service documentation and description approach and provide a preliminary implementation of this concept called the “EMI registry”. The resulting system represents, in our view and that of the reviewers, the state of the art with respect to this type of application provisioning in federated access settings.

The next three papers deal with architectural additions to cloud infrastructures in order to deal with the growing complexity of utilizing multiple IaaS providers. First, J. Farba et al. discusses a bus based approach to transparently resolve federated, cloud

wide, application scaling scenarios across private cloud infrastructures. Next, D. Lezzi et al. introduces the ServiceSs framework which proposes a programming model for operating service based systems on clouds even across federations. In the subsequent paper, the CompatibleOne brokering solution is presented by S. Yangui et al.. This paper demonstrates methods by which a highly functional federated brokering solution can be built in practice on top of newly emergent infrastructure standards such as the Cloud Data Management Interface (CDMI) and Open Cloud Computing Interface (OCCI). While there are many additional examples in other current cloud software stacks of such implementations, this example was selected as particularly illustrative of methods that can be used to create interoperable design implementations through the use of appropriate (although new) software standards.

In the last paper of this special issue, titled “*Towards Standardized Job Submission and Control in Infrastructure Clouds*”, P. Tröger et al. help bridge the gap between grid and cloud interoperability through methods for job submission. In the paper, they analyze the current existing standards and ongoing relevant research in similar fields and then introduce the OCCI-DRMAA standard proposal, which is an elegant use of new and existing popular technologies that should help practitioners to utilize clouds with batch job systems in an interoperable manner even across cloud boundaries.

In summary, through a strong selection and review process, we have tried to bring you the best of the state of the art in practical running systems for cloud interoperability, federation and API definition and use through examples selected from a strong set of submitted papers. While space does not allow the inclusion of other valuable submissions, we hope that the set distilled here will help to bring you fully up to date with the best available described work to illustrate the important progress in this field.