

# Editorial – Theory and Algorithms for Emerging Cloud Computing and its Sustainability

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With dramatically increasing demand on computing and storage systems, IT infrastructures have been scaled tremendously which results in huge amount of energy consumption, heat dissemination, greenhouse emission and even part of climate change. By taking advantage of virtualized resources, cloud computing presents an attractive means to address the challenges while realizing the potential of green and services computing. Consequently, computational scientists are turning their attention to emerging cloud computing architectures. As such, green and sustainable computing has come to the picture seeking solutions for computing and IT infrastructures to be energy efficient and environmentally friendly. This special issue is in response to the increasing convergence between emerging and cloud computing architectures, while different approaches exist, challenges and opportunities are numerous in this context. The research papers selected for this special issue represent recent progresses in the field, including works on heterogeneous computing architectures, energy-aware technology, elastic algorithms, virtualization and networking. This special issue includes five extended version of the selected paper originally presented at the 4th IEEE International Conference on Cloud Computing Technology and Science (IEEE CloudCom 2012), held at Taipei, Taiwan. The papers selected for this issue not only contribute valuable insights and results but also have particular relevance to the emerging and cloud computing architectures. All of them present high quality results for tackling problems arising from the ever-growing cloud computing, heterogeneous computing as well as sustainable computing technologies. We believe that this special issue provides novel ideas and state-of-the-art techniques in the field, and stimulates future research in the emerging and cloud computing community.

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## 1. CLOUD ARCHITECTURE

Current development of the cloud technologies demonstrates movement to developing Inter-cloud models, architectures and integration tools that could allow integration of cloud based infrastructure services into existing enterprise and campus infrastructures, and provide common/interoperable environment for moving existing infrastructures and infrastructure services to virtualized cloud environment. More complex and enterprise oriented use of cloud infrastructure services will require developing new service provisioning and security models that could allow creating complex project and group oriented infrastructures provisioned on-demand and across multiple providers. The paper by Yuri Demchenko, Marc Makkes, Rudolf Strijkers, Canh Ngo and Cees de Laat entitled “Intercloud Architecture Framework for Heterogeneous Multi-Provider Cloud based Infrastructure Services Provisioning” presents on-going research to develop the Inter-cloud Architecture Framework (ICAF) that addresses problems in multi-provider multi-domain heterogeneous cloud based infrastructure services and applications integration and interoperability. The proposed ICAF defines four complementary components addressing Inter-cloud integration and interoperability. The proposed architecture is intended to provide an architectural model for developing Inter-cloud middleware and in this way will facilitate clouds interoperability and integration.

As data centre continue to grow in size, address resolution of IP addresses to MAC addresses using the standard (ARP) is becoming less and less efficient. The paper by Robert Gillespie, Abdullah Kamil, Chung-Horng Lung, Shikharesh Majumdar and Peter Ashwook-Smith entitled “An Efficient Address Resolution Technique for Large Layer 2 Networks” proposed a Distributed Address Resolution Protocol (DARP) for large layer 2 Ethernet networks used in a data center. The proposed work attempts to reduce the overhead in resolving network addresses for large data centers with thousands of nodes and allow for the resolution of network address with minimal

strain on the underlying network infrastructure. The Distributed Hash Tables (DHTs) and the existing Chord protocol was employed to maintain address records. A series of simulations were developed and run via the OPNET Modeler software package. The simulation results demonstrate that DARP outperforms by a significant margin ARP by reducing the number of messages.

## 2. SUSTAINABLE COMPUTING

To satisfy the steadily rising demands on computing performance, both the number of compute units in data/compute centers and the system integration density grow rapidly. Consequently, Power management has become a grave challenge to the development and operation of large scale computing systems. The paper by Yongpeng Liu, Hong Zhu, Kai Lu, and Xiaoping Wang entitled “Self-Adaptive Power Management of Idle Nodes in Large Scale Systems” proposed a new approach to manage the sleep states of idle nodes to ensure low energy consumption and high performance. The proposed approach employs a self-adaptive mechanism in which the sizes of reserve pools are dynamically adjusted during the execution of the system according to how well the research pools serves the need of computation resources. In comparing with existing solutions of power management for large scale systems, the experiments demonstrated that the proposed approach can significantly improve power efficiency in large scale systems.

On the other hand, the paper by Satoshi Takahashi<sup>1</sup>, Atsuko Takefusa, Maiko Shigeno, Hide-moto Nakada, Tomohiro Kudoh and Akiko Yoshise entitled “Power Efficient Virtual Machine Packing for Green Datacenter” proposed two VM packing algorithms, to decide an optimal plan for dealing with the trade-off between power-saving and user experience; VM packing plans within a feasible computational time complexity, and the collision avoidance for multiple VM live migration processes. This work investigates the basic performance and the feasibility of proposed algorithms under both artificial and realistic simulation scenarios. The performance experiments show that the algorithms reduce total power consumption up to 50

## 3. CLOUD ECONOMY

Cloud computing has emerged as a cost-effective way for delivering metered computing resources. It provides a “Pay-as-you-go” model of computation in which users pay only for the resources when used. Within this context managing resource elasticity has been an active research topic for the research community over the past few years with a focus on investigating various approaches that support dynamic scaling of the resources used so as to match the users computational demands while minimising their cost. The paper by Yike Guo, Moustafa M. Ghanem and Rui Han entitled “Towards Elastic Algorithms as a New Model of Computation for the Cloud” introduces the concept of elastic algorithms (EA) that structures the computation to make use of the “Pay-as-you-go” paradigm. An EA is organized to generate a sequence of approximate results corresponding to its resource consumption. On a tight budget of resources, the user is guaranteed a useful result. The work presented here provides a foundation for developing further examples of elastic algorithms for both machine learning and scientific applications. The authors also describe a number of key challenges that need to be addressed when designing EAs and set them as research agenda for the community.

## 4. SUMMARY

All of the above papers address either energy issues in emerging cloud computing architectures or propose novel application models in the various heterogeneous computing fields. They also trigger further related research and technology improvements in application of sustainable computing. Honorably, this special issue serves as a landmark source for education, information, and reference to professors, researchers and graduate students interested in updating their knowledge about or active in cloud and green computing, resource provisioning and management, and novel application models for services computing systems. This special issue of International Journal of Next Generation Computing covers different aspects of the problem, both from the theoretical to

practical side. Five research papers were selected by an international editorial committee. Each paper was reviewed by at least 3 reviewers. The guest editor would like to express sincere gratitude to Dr. Vijay Kumar (EiC, IJNGC), for giving the opportunity to prepare this special issue. In addition, I am deeply indebted to numerous reviewers for their professional effort, insight and hard work put into commenting on the selected articles which reflect the essence of this special issue. Last but not least, I am grateful to all authors for their contributions and for undertaking two-cycle revisions of their manuscripts, without which this special issue could not have been produced.

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