Guest Editor’s Introduction: Special Section on Services and Software Engineering Towards Internetware

M. Brian Blake, Senior Member, IEEE, Abdelsalam (Sumi) Helal®, Fellow, IEEE, and Hong Mei, Fellow, IEEE

1 INTRODUCTION

SERVICES computing provides a foundation to build software systems and applications over the Internet as well as emerging hybrid networked platforms motivated by it. Due to the open, dynamic, and evolving nature of the Internet, new features were born with these Internet-scale and service-based software systems. Such systems should be situation-aware, adaptable, and able to evolve to effectively deal with rapid changes of user requirements and runtime contexts. These emerging software systems enable and require novel methods in conducting software requirement, design, deployment, operation, and maintenance beyond existing services computing technologies. New programming and lifecycle paradigms accommodating such Internet-scale and service-based software systems, referred to as Internetware, are inevitable. The goal of this special section is to present the innovative solutions and challenging technical issues, so as to explore various potential pathways towards Internet-scale and service-based software systems.

This special Section includes six quality articles that report in-depth, new research results on Services and Software Engineering towards Internetware, in terms of, among other perspectives, programming model, development, runtime, and quality assurance. The first article “Programming Situational Mobile Web Applications with Cloud-Mobile Convergence: An Internetware-Oriented Approach” is authored by Gang Huang, Xuanzhe Liu, Yun Ma, Xuan Lu, Ying Zhang, and Yingfei Xiong. This article describes an Internetware-oriented approach to designing, developing, and deploying situational mobile Web apps, based on the guiding principle of synthesizing the resources and services of mobile and cloud, i.e., cloud-client convergence. Per a novel Service-Model-View-Controller (SMVC) programming abstraction, this paper makes a mobile Web app organized into a well-defined structure that facilitates adapting to dynamic network environments, including online/offline data access, computation offloading, user interface optimization, hybrid composition, etc. This article also provides an efficient runtime support spanning mobile and cloud, and implements a prototype that can be seamlessly built upon existing mobile Web infrastructure. The proof-of-concept evaluation demonstrates that the proposed approach can benefit end-users with optimized user experience of mobile Web apps.

The second article “A Requirement-Driven Mechanism for the Management of Distributed Infrastructures” is authored by Souheil Khaddaj and Bippin Makoond. It presents a requirement-driven decision-making mechanism for the management, distribution, control and optimisation of systems resources within distributed systems with assured QoS. The mechanism comprises of two brokering components: a system-centric broker that optimizes the supplier’s resources and a user-centric broker that ensures meeting the user requirements and SLAs. This article empowers adaptation strategies that provide autonomy to several parts of a system and its novelties lie in the ability to use a multitude of quality attributes for decision making, a set of quality guidelines from the user, and applying a reinforcement model to validate these guidelines, when required.

The third article “ROSF: Leveraging Information Retrieval and Supervised Learning for Recommending Code Snippets” is authored by He Jiang, Liming Nie, Zhilei Ren, Weiqiang Kong, Tao Zhang, and Xiapu Luo. It proposes ROSF, an approach for recommending code snippets with multi-aspect features based on information retrieval and supervised learning. The approach can generate a code snippet candidate set by searching a code snippet corpus using an information retrieval method, and can predict the probability values of the code snippets for different relevance scores in the candidate set by the learned prediction model. Based on several experiments along with a large-scale corpus, this article demonstrates its effectiveness and outperforms the state-of-the-art methods.

The fourth article “Multi-Dimensional QoS Prediction for Service Recommendations” is authored by Shangguang Wang, You Ma, Bo Cheng, Fangchun Yang, and Rong N. Chang. Compared with most existing QoS prediction methods that exploit the QoS characteristics for only one specific dimension (e.g., time or location) and do not exploit the structural
relationships among the multi-dimensional QoS data, this article proposes an integrated QoS prediction approach that unifies the modeling of multi-dimensional QoS data. The authors leveraged the multi-linear algebra-based concept of tensor to enable efficient Web service recommendation for mobile clients via tensor decomposition and reconstruction optimization algorithms. In light of the unavailability of measured multi-dimensional QoS datasets in the public domain, this paper also presents a transformational approach to creating a credible multi-dimensional QoS dataset from a measured taxi usage dataset that contains high dimensional time and space information. Comparative experimental evaluation results show that the proposed QoS prediction approach can achieve satisfactory performance in recommending Web services than representative reported efforts.

The fifth article “Storage Sharing Optimization under Constraints of SLO Compliance and Performance Variability” is authored by Ning Li, Hong Jiang, Dan Feng, and Zhan Shi. It proposes an end-to-end VM-oriented control framework, named SASLO, for supporting user-customizable SLO targets and QoS constraints for each VM. The SASLO framework can dynamically coordinate the throughput target and I/O size limit for each VM adapting to the status of SLO enforcement so as to maximize the I/O capacity allocation among consolidated VMs under QoS constraints. This article also accurately enforces time-varying throughput target and establishes a proportional-integral I/O controller for each individual VM to converge the actual throughput to the target with an expected settling time. With an extensive evaluation driven by representative benchmarks, this article demonstrates that SASLO is able to formulate a satisfactory I/O capacity allocation plan for consolidated VMs under the constraints of SLO compliance and performance variability.

The sixth article “Architecture-Based Behavioral Adaptation with Generated Alternatives and Relaxed Constraints” is authored by Bihuan Chen, Xin Peng, Yang Liu, Songzheng Song, Jiahuan Zheng, and Wenyuo Zhao. This article proposes a new architecture-based self-adaptation approach which performs behavioral adaptations with automatically generated alternatives and supports relaxed functional constraints from the perspective of business value. A novel technique is employed to automatically generate behavioral alternatives of a software system from the architectural behavioral specification in use. This article also introduces a genetic algorithm-based planning technique to efficiently search for the optimal (sometimes a near-optimal) behavioral alternative in terms of business outcome. The experimental study using an online order processing benchmark demonstrates that the approach is promising for online adaption with insignificant overhead.

In summary, the goal of this special section is to crystallize the emerging technologies and trends into positive efforts in services and software engineering towards Internetware. We hope that the novel research contributions of the papers in this special section will provide interesting insights for further advancements in modeling, engineering, and managing Internet-scale and service-based software systems.

We thank all authors who submitted their quality manuscripts to this special section. We are grateful to all reviewers for their providing insightful and timely evaluations for the submitted manuscripts. We owe special thanks to the former Editor-in-Chief, Prof. Ling Liu, for her encouragement and suggestions throughout the special issue planning and execution phases. Finally, we thank the Editor-in-Chief, Prof. James Joshi, the Associate Editor-in-Chief, Dr. Rong N. Chang, and the Administrator, Ms. Christine Kurzawa of IEEE Transactions on Services Computing for their constant and valuable support.

M. Brian Blake
Abdelsalam Helal
Hong Mei
Guest Editors