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José Ángel Bañares · Konstantinos Tserpes
Jörn Altmann (Eds.)

Economics of Grids, Clouds, Systems, and Services

13th International Conference, GECON 2016
Athens, Greece, September 20–22, 2016
Revised Selected Papers

Editors

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Spain

Jörn Altmann
Seoul National University
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Korea (Republic of)

Konstantinos Tserpes
Harokopio University of Athens
Tavros
Greece

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Preface

The 13th edition of GECON, the International Conference on the Economics of Grids, Clouds, Systems, and Services, took place in Athens, Greece, the cradle of Western civilization and the birthplace of democracy. The term economics comes from the Ancient Greek words *oikos* (house) and *nomos* (custom, law). Several ancient Greek thinkers made various economic observations, especially Aristotle, Xenophon, and Plato. We emulated ancient Greek thinkers on the main campus of Harokopio University of Athens, which is located close to many important cultural sites of interest such as the Acropolis Museum, Thissio, Panathenaic Stadium (Kallimarmaron), Keramikos, and the Benaki Museum.

The aim of the GECON conference is to bring together distributed systems expertise (e.g., in resource allocation, quality of service management and energy consumption) with economics expertise (focusing on both micro- and macro-economic modelling and analysis), in order to create effective solutions in this space. Thirteen years later, GECON continues to focus on the marriage of these two types of expertise, reinforced by the increasing intertwinement of economy and technology. The world of production is becoming more and more networked, until everything is interlinked with everything else with unexpected consequences. Today distributed systems include a network of physical devices, vehicles, buildings, wearables, and cyber-physical systems with capacity to act on the environment. In the connected world, we cannot separate the physical world from business processes. Economy and IT technologies cannot be considered as separate disciplines. In this context, we return to the ancient point of view of Greek thinkers and consider economics and IT technologies as a factor of ethics, politics, and laws.

For this year's edition, we received 38 submissions. Each submission was assessed by three to five reviewers of the international Program Committee. Of these 38 submissions, 11 were selected as full papers with an acceptance rate of 29%. Additionally, shorter work-in-progress papers were integrated in the volume. This combination of full and work-in-progress papers fulfills the twofold aim of gathering original work to build a strong multidisciplinary community in this increasingly important area of a future information and knowledge economy, and enabling a more open and informed dialogue between the presenters and the audience. Our intention in increasing the number of accepted work-in-progress papers is underpinned by the conviction that the GECON conference is the best framework for the presenters to better position their work for future events and to get an improved understanding of the impact their work is likely to have on the research community. The schedule for the conference this year was structure to encourage discussions and debates, with enough discussion time included in each paper presentation session, led by the session chair.

This volume is structured following the seven sessions that comprised the conference program (three of which are work-in-progress sessions):

Session 1: Business Models

Session 2: Work in Progress on Quality of Services and Service Level Agreements

Session 3: Work in Progress on Cloud Economics

Session 4: Energy Consumption

Session 5: Resource Allocation

Session 6: Work in Progress on Resource Allocation

Session 7: Cloud Applications

Session 1 started with two papers about brokers and application composers. The first paper by Zherui Yang, Slinger Jansen, Xuesong Gao, and Dong Zhang is a vision paper entitled “On the Future of Solution Composition in Software Ecosystems” that introduces the need for solution composers as an evolution or replacement of application stores. The authors sketch a solution composer framework, which illustrates how they believe software in the future will be shaped by end-users, consultants, and developers. The vision is evaluated through expert reviews at several leading platform providers. The next paper, “The Rise of Cloud Brokerage: Business Model, Profit Making and Cost Savings” by Evangelia Filiopoulou, Persefoni Mitropoulou, Christos Michalakelis and Mara Nikolaidou, focuses on the search for the best provider or the best bundle through a broker. The paper highlights the pros that arise from the use of the broker’s services and the cons from the intermediation. The authors also review the contemporary literature on the pricing methods that can be adopted by a cloud broker in order to achieve cost savings; they also describe different pricing models for cloud brokers by summarizing the main characteristic and evaluation results.

Session 2 was a work-in-progress session on quality of service (QoS) and service-level agreement (SLA) management. The first contribution is the paper by Nikoletta Mavrogeorgi, Athanasios Voulodimos, Vassilios Alexandrou, Spyridon Gogouvitis, and Theodora Varvarigou entitled “Robust Content-Centric SLA Enforcement in Federated Cloud Environments.” This paper presents an SLA management framework for declaring, enforcing, and negotiating SLAs in cloud environments, where commitments for using cloud services are defined. In this framework developed within the EU project VISION cloud, the SLA schema is enriched with content terms, and sections for storlets and federation. Dynamic SLAs are supported, since the SLA templates are generated according to the current supplies, and a renegotiation possibility is offered. Finally, dynamic rules are created and updated, in order to detect and handle proactively SLA violations. Along the same lines, the second contribution by Waheed Aslam Ghumman and Alexander Schill entitled “Structural Specification for the SLAs in Cloud Computing (S3LACC)” proposes a structural specification for the SLAs in cloud computing for the automation of a complete SLA life cycle, i.e., negotiation, monitoring, management, and recycling. The specification targets complex dependencies among different metrics and the composition of different metrics in one service-level objective. The proposed SLA structure can be used to implement almost all types of negotiation strategies and monitoring policies for an automated SLA life cycle. The third paper by Antonios Makris, Konstantinos Tserpes, and Dimosthenis Anagnostopoulos – “Load Balancing in In-Memory Key-Value

Stores for Response Time Minimization” – investigates key/data distribution within in-memory key-value stores and how this affects query response time. The paper focuses on an evaluation of the core factors influencing the performance of Redis. Experimental results show that key distribution and key length are contributing factors to the load balancing problem and impact the cluster’s response times. Finally, in “Fault-Tree-Based Service Availability Models in Cloud Environments: A Failure Trace Archive Approach,” Alexandru Butoi and Gheorghe Cosmin Silaghi present a probabilistic model for evaluating the service reliability in cloud systems. The authors provide a method for extracting failure events and then show how to use replication or migration to provide service reliability.

Session 3, which comprised work-in-progress papers on cloud economics related to security, recommender systems, and market models, started with the contribution of Mathias Slawik, Begüm Ilke Zilci, Axel Küpper, Yuri Demchenko, Fatih Turkmen, Christophe Blanchet, and Jean-Francois Gibrat, entitled “An Economical Security Architecture for Multi-Cloud Application Deployments in Federated Environments.” The authors propose an architecture for security in federated environments, which fulfills the requirements of various stakeholders. They provide a design rationale, evaluate the resulting architecture, and offer readily instantiable components in their public code repository. The second contribution in this session is “Efficient Context Management and Personalized User Recommendations in a Smart Social TV Environment” by Fotis Aisopos, Angelos Valsamis, Alexandros Psychas, Andreas Menychtas, and Theodora Varvarigou. It focuses on smart TV recommendations. The authors present a new efficient context management approach, to provide personalized multi-level recommendations via a hybrid method combining graph analysis and collaborative filtering. The last paper in this session, entitled “When Culture Trumps Economic Laws: Persistent Segmentation of the Mobile Instant Messaging Market” by Maria C. Borges, Max-R. Ulbricht, and Frank Pallas, discusses the general characteristics of the mobile instant messaging market from a competition point of view. It highlights the fact that no single player has achieved domination of the global market, in contrast to what has happened in digital social networks. The authors point out that the distinct communication style of different cultures is one of the reasons the market has not tipped yet.

Session 4 consisted of four papers on energy consumption and cost in cloud systems, which is a consolidated research area within cloud computing and present in the last GECON conferences. The paper by Karim Djemame, Richard Kavanagh, Django Armstrong, Francesc Lordan, Jorge Ejarque, Mario Macias, Raül Sirvent, Jordi Guitart, and Rosa M. Badia entitled “Energy Efficiency Support Through Intra-Layer Cloud Stack Adaptation” focuses on the embedding of energy efficiency support in each of the typical cloud abstraction layers: SaaS, PaaS, and IaaS. The authors describe a properly conceived system architecture using an intra-layer self-adaptation methodology tailored for SaaS, PaaS, and IaaS to achieve an intra-layer support to energy efficiency. The second paper by Alexandros Kostopoulos, Eleni Agiatzidou, and Antonis Dimakis entitled “Energy-Aware Pricing Within Cloud Environments” presents pricing schemes used by a set of current infrastructure and platform-as-a-service (IaaS/PaaS) providers and then proposes a set of four different pricing schemes that take into account the energy consumption of virtual machines in an IaaS environment. In “Energy Prediction for Cloud Workload Patterns,” Ibrahim Alzamil and Karim Djemame propose the

necessity of having proactive and reactive management tools with energy-awareness at a virtual machine (VM) level in order to enhance decision-making. In this paper, the authors introduce an energy-aware profiling model that enables the attribution of a physical machine's energy consumption to homogeneous and heterogeneous VMs based on their utilization and size. The fourth contribution by Muhammad Zakarya and Lee Gillam entitled "An Energy-Aware Cost-Recovery Approach for Virtual Machine Migration" investigates how migration decisions can be made such that the energy costs involved with the migration are recovered.

Session 5 focused on resource allocation, one of the classic research areas in cloud computing and in previous GECON conferences. The contribution of Patrick Poullie and Burkhard Stiller entitled "The Design and Evaluation of a Heaviness Metric for Cloud Fairness and Correct Virtual Machine Configurations" presents a runtime prioritization mechanism for a fair assignment of resources to virtual machines according to their respective utility function and greediness. The paper "A History-Based Model for Provisioning EC2 Spot Instances with Cost Constraints" by Javier Fabra, Sergio Hernández, Pedro Álvarez, Joaquín Ezpeleta, Álvaro Recuenco, and Ana Martínez presents and evaluates a framework for the analysis of the EC2 spot instances as a cheap public infrastructure. It uses the price history of such resources to generate a provisioning plan by means of a simulation algorithm considering cost constraints. The authors achieved savings of up to 88% using their framework to generate a provisioning plan for the deployment of a specific instance in regions of the EC2 cloud with different price variations observed.

Session 6 consisted of four work-in-progress papers focusing on resource allocation problems. Azamat Uzbekov and Jörn Altmann in their paper entitled "Enabling Business-Preference-Based Scheduling of Cloud Computing Resources" explicitly try to link economic and technical issues by presenting an architecture that connects the technical layer of resource allocation with the business strategy layer of a cloud service provider. The contribution of Benedikt Pittl, Werner Mach, and Erich Schikuta entitled "Bazaar-Score: A Key Figure Measuring Market Efficiency in IaaS-Markets" presents a novel genetic algorithm-based multi-round negotiation strategy between providers and consumers of services enabling the creation of approximately Pareto-optimal offers. The authors define the Bazaar Score, a key figure based on economic utility theory enabling the comparison of different resource allocations. The third paper in this session "Understanding Resource Selection Requirements for Computationally Intensive Tasks on Heterogeneous Computing Infrastructure" by Jeremy Cohen, Thierry Rayna, and John Darlington presents a decision support system to identify the most suitable computing platform and configuration for a computational task based on a user's financial and temporal constraints. The system builds on approaches presented in the extant economics literature, to help identify a user's risk aversion and the opportunity cost of different platform choices. The last paper in this session, entitled "Towards Usage-Based Dynamic Overbooking in IaaS Clouds" by Athanasios Tsitsipas, Christopher B. Hauser, Jörg Domaschka, and Stefan Wesner, looks into the issue of overbooking physical machines in a cloud data center. The authors investigate pre-conditions that have to be enabled in a data center to support dynamic overbooking, and they describe a prototype implementation with OpenStack.

The final session consisted of three papers on the economic implications of three different cloud applications. The session began with the paper by Hyeong-Il Kim, Hyeong-Jin Kim, and Jae-Woo Chang entitled “A Privacy Preserving Top-k Query Processing Algorithm in Cloud Computing.” The paper deals with privacy concerns and databases that need to be encrypted before being outsourced to the cloud. The authors focus on preserving the privacy of a user query and propose a query-processing algorithm that guarantees the confidentiality of data and hides data access patterns. The second paper by Salman Taherizadeh, Ian Taylor, Andrew Jones, Zhiming Zhao, and Vlado Stankovski entitled “A Network Edge Monitoring Approach for Real-Time Data Streaming Applications” deals with the problem of enforcing service quality in streaming systems that must consider real-time variations in the network quality. The authors show how edge services for time-critical applications could be used to automatically optimize the process of allocating and choosing the best infrastructure, and they investigate network-level metrics that are particularly important for the development and adaptation of time-critical applications. The final paper in this session by Victor Medel, Unai Arronategui, José Ángel Bañares, and José Manuel Colom entitled “Distributed Simulation of Complex and Scalable Systems: From Models to the Cloud” deals with the problem of translating a simulation to the cloud, providing users with appropriate tools to hide the modeler low-level details of this migration process considering cost and performance requirements. The authors give a central focus to Petri net models, describing the behavior of the system including timing and cost information. They propose a way to automatically translate high-level specifications to an executable model suited to be partitioned on the cloud.

Finally, we would like to wholeheartedly thank the reviewers and Program Committee members for completing their reviews on time, and giving insightful and valuable feedback to the authors. Furthermore, we would like to thank Alfred Hofmann of Springer for his support in publishing the proceedings of GECON 2016. The collaboration with Alfred Hofmann and his team has been, as in the past, efficient and effective.

September 2016

José Ángel Bañares
Konstantinos Tserpes
Jörn Altmann

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