Preface

Service-oriented computing has emerged as a computing paradigm capable to change the way systems are designed, architected, deployed, and used. It decomposes computation into a set of loosely-coupled and possibly cooperating services that can be arranged and integrated in a new manner to create flexible and dynamic applications.

When deployed as infrastructural components of business processes, service-oriented systems elicit the proper addressing of performance and dependability issues. While recent developments in service computing have come a long way in many aspects, ranging from semantics and ontologies to frameworks and design processes, performance and dependability issues remain a research demanding field. Since the activities of our daily lives are increasingly dependent on service-oriented systems, the analysis and assessment of the Quality of Service (QoS) delivered by these systems, in terms of their performance, dependability, and security is crucially important. Furthermore, with the spread of cloud computing as a service delivery platform and the envisioned “Internet of Services”, where everything that is needed to use software applications is available as a service on the Internet, performance and dependability issues are expected to become even more critical. In these scenarios, a number of factors, including the nondeterministic dynamics of network environment, the diversity of resources and requirements, and the loose coupling architectural principle of service-oriented computing, pose various challenges to the methodologies and techniques that aim at meeting both functional and non-functional requirements of service-oriented systems and demand a joint effort from diverse but related research communities.

The book, entitled “Performance and Dependability in Service Computing: Concepts, Techniques and Research Directions” is conceived under this perspective and offers some state-of-the-art contributions covering concepts, principles, methodologies, modeling, engineering approaches, applications, and recent technological developments that can be adopted to improve the performance and dependability of service-oriented systems. The book builds on academic and industrial research efforts that are been carried out at many different institutions around the world. In addition, the book identifies potential research directions that can drive future innovations.

We expect the book to serve as a valuable and useful reference for researchers, practitioners, and graduate level students. It deals with performance and dependability issues in service computing that are certainly of interest to the practitioners in understanding some practical problems that may be faced during the management of real-world service-oriented systems. At the same time, the book is of interest for researchers as it contains a set of contributions that were consciously selected for their novelty and for their research value. In addition, the book contains some fundamental methods, concepts, and principles that can be valuable for graduate level students who wish to learn and spot the opportunities for their studies in this emerging research and development area. Researchers and students can also find useful references for further study.
ORGANIZATION OF THE BOOK

All the contributions have been reviewed, edited, processed and placed in the appropriate order to maintain consistency so that any reader would get the most out of it. The organization we describe below ensures the smooth flow of material, as successive chapters build on previous ones. However, each chapter is self-contained to provide greatest reading flexibility.

The book is organized in four sections. Section 1, namely Foundations, introduces the concepts of Service Level Agreement (SLA) in utility computing and enterprise service computing, the theoretical foundation of dependability modeling, the concepts and research issues in SOA validation as well as in collaborative business processes. Section 2, namely Performance, encompasses research works presenting issues and solutions related to the modeling and performance-oriented design of service-oriented systems and, more in general, Internet services. This section of the book is mainly related to QoS aspects. Section 3, namely Dependability, embraces chapters discussing approaches for the modeling, evaluation, and enforcement of dependability and performability (that is, the integration of performance and dependability in a unique approach) in service-oriented systems. The third section concludes with a chapter discussing dependability and security issues in pervasive service-oriented systems. Section 4, namely Security, is devoted to research works on security engineering, testing, and vulnerability detection in service-oriented systems.

The topics discussed in the book are the following:

- SLA definition, management and use
- SLA models for SOA and Cloud
- QoS-aware SOA and Web services
- Models and methodologies for service composition and selection
- Models and methodologies for dependability evaluation of service-oriented systems
- Capacity planning in service-oriented systems
- Performance and dependability issues for pervasive service-oriented computing
- Self-adaptive SOA and Internet services
- Performance, dependability, and security assessment of service-oriented systems
- Methodologies and tools for SOA monitoring, testing, and validation
- Security in service-oriented systems and Web services
- Real-time issues in service-oriented computing
- Engineering of service-oriented systems

Section 1: Foundations

In Chapter 1, Wu and Buyya present a comprehensive survey of how SLAs are created, managed and used in utility computing environment. The chapter introduces the foundation of SLA and utility computing architecture. The authors discuss existing use cases from Grid and Cloud computing systems to identify the level of SLA realization in state-of-the-art systems and the emerging challenges for future research.

In Chapter 2, Tang et al. propose the SLA-aware Enterprise Service Computing (ESC) as a solution to the challenges and issues of ESC. SLA-Aware ESC is defined as a new architectural style and it is specified through the extended enterprise SOA and enterprise cloud service architecture models previously proposed by the authors. The chapter discusses also the challenges of SLA-aware ESC and
suggests that the autonomic, automated, and adaptive service computing as well as real-time SOA and event-driven architectures can help to address the identified challenges.

In Chapter 3, Maciel et al. present modeling methods and evaluation techniques for computing dependability metrics of systems. The chapter provides an extensive summary of seminal works; the most prominent model types are presented, as well as the respective methods for computing exact values and bounds. Moreover, the chapter is enriched with case studies related to the dependability evaluation in multiprocessor subsystems and virtualized subsystems that are the basic architectural elements for platforms running service-oriented systems.

In Chapter 4, Bertolino et al. discuss issues and opportunities of SOA validation, identify three different stages for validation along the service life-cycle model, and provide an overview of related research approaches and tools. The emphasis is on on-line testing, which is the most peculiar stage in the SOA validation process and turns out to be possible only within an agreed governance framework.

In Chapter 5, Xu et al. describe a new landscape for supporting collaborative business processes. The authors presented different solutions and tools for collaborative business process applications as well as propose a new approach for supporting situational collaborative business processes. The chapter also discusses the benefits of using process-oriented mashups and highlights their security and scalability challenges.

Section 2: Performance

In Chapter 6, Dubey and Menascé describe the architecture of a QoS broker that manages the performance of composite applications. The proposed solution relies on continuous monitoring of the utility of the applications and threshold-based triggering of new service selection when the utility collapses or when a service provider fails. A proof-of-concept prototype of the QoS broker demonstrates how it maintains the average utility of the composite application above the threshold in spite of service provider failures and performance degradation.

In Chapter 7, Liang and Parkin explore an approach to discover services, differentiated by their QoS attributes, and to configure an abstract business process by selecting an optimal configuration of the “best” QoS combinations. The proposed approach takes into account the optimal choice of multi-dimensional QoS attributes. The authors present and compare two solutions based on heuristic algorithms to illustrate how this approach would work practically.

In Chapter 8, Merad et al. consider the problem of run-time optimal service selection with respect to their non-functional attributes and costs. This problem, which has been largely investigated in literature, is addressed by the authors in a new way through a game theoretic solution. After having introduced some useful background on game theory and bargaining games, the authors present their problem formulation as a bargaining game.

In Chapter 9, Hollunder et al. present a tool chain that facilitates development, deployment, and testing of QoS-aware Web services. The tool chain presents as features the integration of standard components such as widely used IDEs, the usage of standards and specifications, and the support for various application servers and Web services infrastructures. Moreover, the authors exemplify the usage of the tool chain by means of three examples: robustness with respect to erroneous input, application-specific QoS attributes, and accounting.

In Chapter 10, Arnaud and Bouchenak present an approach for building self-adaptive Internet services. Their solution is based on an analytic model to predict Internet service performance, availability and
cost, and on a utility-aware capacity planning method to calculate the optimal service configuration that guarantees SLA objectives while minimizing functioning costs. An adaptive control method is proposed to automatically apply the optimal configuration to Internet services. The chapter is enriched with an extensive experimental evaluation of the proposed solution applied to an online bookstore.

Section 3: Dependability

In Chapter 11, Martinello et al. present a systematic modeling approach that allows the designers of a web-based service to evaluate its performability. The authors develop a multi-level modeling framework to analyze the user-perceived performability. The main concepts and the feasibility of the proposed framework are illustrated using a web-based travel agency. Various analytical models and sensitivity studies are presented, considering different assumptions with respect to users profiles, architecture, faults, recovery strategies, and traffic characteristics.

In Chapter 12, Chen et al. investigate the uncertainty of Web services performance and the instability of their communication medium and show the influence of these two factors on the overall dependability of SOA. Benchmarking and measuring the behavior of a number of existing Web services used in e-science and bio-informatics, the authors provide the results of statistical data analysis and characterize the distribution of the delays that contribute to the Web services response time. The chapter also introduces a new metric to measure the performance uncertainty of a Web service and present experimental results of error and fault injection into Web services.

In Chapter 13, Sun et al. provide an insightful analysis of the dependability issue of composite services. The authors present a solution based on two-level redundancy: component service redundancy and structural redundancy. Component service redundancy is used to determine the number of backup services and to guarantee consistent dependability of a composite service, while structural redundancy aims at further improving the dependability at the business process level by setting up backup execution paths.

In Chapter 14, Laranjeiro et al. present a framework to deploy Web services with temporal failure detection and prediction capabilities. The failure detection is based on timing restrictions defined at execution time and historical data are used for failure prediction. The framework enables providers to easily develop and deploy time-aware Web services, with the failure detection code decoupled from the application logic, and allows consumers to express their timeliness requirements.

In Chapter 15, Nogueira et al. present a general discussion about survivability in wireless self-organized networks (WSONs), its concepts and properties. The authors emphasize open issues and survivability requirements for WSONs and their effects on the network characteristics. Further, this work surveys the main solutions that have applied survivability concepts to WSONs, such as architectures of network management, routing protocols and key management systems.

Section 4: Security

In Chapter 16, Rodrigues et al. discuss state-of-the-art techniques and tools for the deployment of secure web services, including standards and protocols for the deployment of secure services, and security assessment approaches. The chapter also discusses how relevant security aspects can be correlated into practical engineering approaches.

In Chapter 17, Bartolini et al. provide an overview of recently proposed approaches and tools for functional and structural testing of SOA services. Although these two classes of approaches have been
considered separately, being focused on different perspectives, they are generally non-conflicting and could be used in a complementary way. Therefore, the authors propose their combination, briefly showing the approach and some preliminary results of the experimentation. In addition, the authors also discuss security testing challenges and the proposed solutions to address them.

Finally, in the last chapter of the book, Antunes and Vieira present two case studies on the effectiveness of several well-known vulnerability detection tools and discuss their strengths and limitations. Based on the lessons learned, the chapter also proposes a benchmarking technique that can be used to select the tool that best fits a specific scenario. The main goal of the authors is to provide to the Web service developer information on how much she/he can rely on widely used vulnerability detection tools and on how to select the most adequate tool.

Despite the main organization above introduced, we also provide alternative keys to drive the readers interested in more specific arguments. The reader interested in modeling of performance and dependability in service-oriented computing can directly go through Chapters 3, 6, 8, 10, 11, and 13. Engineering aspects of performance and dependability are mainly discussed in Chapters 4, 5, 9, 12, 14, 15, 16, 17 and 18. Finally, the reader interested in QoS and SLA specific matters can leaf through Chapters 1, 2, 6, 7 and 9.

We hope that this book will serve as a useful text for graduate students and a valuable reference for researchers and practitioners that address performance and dependability issues in service computing.

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