Service-Oriented Computing and Web Software Integration
From Principles to Development

Third Edition

Yinong Chen
Wei-Tek Tsai
THIRD EDITION

SERVICE-ORIENTED COMPUTING AND WEB SOFTWARE INTEGRATION
FROM PRINCIPLES TO DEVELOPMENT

YINONG CHEN AND WEI-TEK TSAI

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Programming Conditions in VPL

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Preface (This Edition)

Web software development and cloud computing based on Service-Oriented Architecture (SOA) and Service-Oriented Computing (SOC) represent the modern software engineering theory, practices and technologies. The book takes a comprehensive and coherent approach to address these issues. The goal is to learn the concepts, principles and methods in advanced software architecture, software engineering, and software development. The approach is learning by developing. We assume students have basic understanding of software architecture, and this book takes an architecture-driven approach to help students creating working solutions for their architecture design, including programming and code deployment. The text consists of fourteen chapters and two appendices, which are organized into three parts.

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Each part is relatively independent and can be used in a different course. Part I includes the first six chapters, which can be used for a service-oriented computing and distributed software development course at the senior level or graduate level of universities. This part emphasizes the computing paradigm, data representation, data management, and programming language-based SOC software development. It introduces fundamental concepts and principles, in addition to technologies and tools, which have not
been taught in traditional software engineering courses. This part covers multithreading, event-driven programming, service-oriented development, Web-based programming, Web data management, and reliability and security mechanism development.

Part II includes the next eight chapters. These chapters are built on the basic concepts and principles discussed in Part I, yet they do not rely on the detail of the first six chapters. This part emphasizes software composition and integration using services and components. The approach is based on higher-level of data management and application building techniques. Part II covers advanced service and application development and integration in Windows Communication Foundation, Workflow Foundation for application integration, Business Process Execution Language (BPEL) for enterprise software integration, and Visual Programming Language (VPL) for event-driven software development and robotics applications, interfaces between service-oriented software and databases, ontology languages and applications, service-oriented application architecture, and cloud computing. The materials in Part II can be used for a senior or graduate course on advanced software engineering and software integration. While most contents in Part II are based on matured knowledge and technologies, many research questions are also discussed to help graduate students to identify their research directions and topics.

Part III Appendix A and Appendix B contain tutorial-based materials that provide stepwise instructions, without missing pieces, to build working applications from scratch. These tutorials and exercises can help students to learn concepts by examples. This part can also be used for a freshman level course to introduce computing concepts through robotics programming and Web application programming. Appendix C lists the deployed examples and URLs of services, applications, and other resources used in this text.

At Arizona State University, we use the book as the text for two courses. The first course is CSE445/598 (Distributed Software Development), where the CSE445 session is for seniors and the CSE598 session is for graduate students. This course mainly teaches the content from Part I. Biweekly programming assignments and projects are given at the end of each chapter.

Part II of the book is used for a newly developed course CSE494/598 (Software Integration Engineering) for seniors and graduate students.

We recommend teaching the two courses in a sequence. However, the two courses can be taught independently without making one to be the prerequisite of the other. In this case, the basic concepts and principles from Part I, including those from a part of Chapter One and the first section of Chapter Four, should be reviewed or be assigned as reading materials for preparing the required concepts to start the course using Part II.

The first edition of the book covered the concepts, principles, methodology, and the latest technologies in service-oriented software development. As this field is still a rapidly developing young field, many new concepts as well as technologies have emerged since the publication of the first edition in 2008. In the latest edition of the book, we have embraced a large part of the new knowledge, including concepts, principles, and technologies developed in the past years. Five new chapters are added, and all the other chapters have been significantly revised and extended. The new chapters include the following:

Chapter Five on Web application and data management, which discusses stateful Web application development using different state management techniques, including view state, session state, application state, file management, Web caching, and dynamic graphics generation.

Chapter Seven on service-oriented and resource-oriented computing, which introduces Web service development, service hosting, RESTful service development in Windows Communication Foundation, and workflow development and application integration in Workflow Foundation.
Chapter Nine on service-oriented computing in robotics applications, which studies Visual Programming Language (VPL) and uses it to develop robotics services and applications. Distributed robotics applications and Robot-as-a-Service (RaaS) are also presented.

Chapter Ten on service-oriented database management, which presents the interface between service-oriented software and relational database, XML database, and LINQ (Integrated Language Query) and using LINQ to access object, relational database, and XML database.

Chapter Fourteen on cloud computing, which introduces the most recent trend in SOC. It covers multi-tenancy architecture, Web databases and file systems, scheduling, fault-tolerant techniques, and real-time computing. It also presents cloud computing platforms and development environments from Google, Microsoft, and Salesforce.com. Software-as-a-Service is the focus of the chapter.

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Note for Instructors

All the assignments and projects have been classroom-tested at Arizona State University. Furthermore, all the code presented in this book has been developed and tested. Contact the authors if you are interested in obtaining more materials in this book. Instructor-only resources, such as presentation slides, assignments, and tests, can be obtained by directly contacting the authors at {yinong, wtsai}@asu.edu.

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