



"This book illuminates the connection of the two domains—SOA and REST—in a manner that is concrete and practical, providing concise application to everyday architectural challenges. Fantastic!"

—Ryan Frazier, Technology Strategist, Microsoft

"...a tour de force that elegantly applies REST principles to the industry-standard SOA framework described in prior titles in this series.... This book is a must-read for anyone developing REST services."

—Dave Slotnick, Enterprise Architect, Rackspace Hosting

"This book undoubtedly will help SOA to reap the benefits from the main value propositions of Web architecture...."

—Dr. Erik Wilde, Architect, EMC Corporation

SOA with REST

Principles, Patterns & Constraints for Building Enterprise Solutions with REST

Co-authored and Edited by Thomas Erl, World's Top-Selling SOA Author
Co-authored by Benjamin Carlyle, Cesare Pautasso, Raj Balasubramanian
Foreword by Stefan Tilkov



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*Principles, Patterns & Constraints
for Building Enterprise Solutions with REST*

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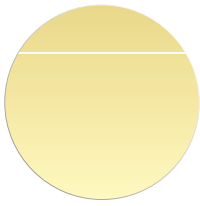
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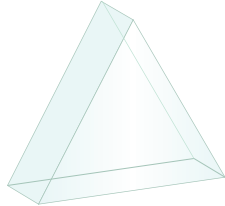
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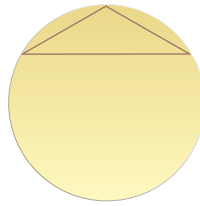




service contract
(chorded circle notation)



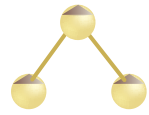
uniform
contract



service contract accessed
via a uniform contract
(chorded circle notation)



REST service
(labeled)



REST service
composition



component
or program



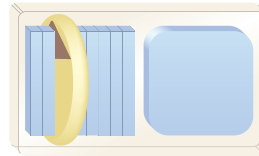
decoupled
service
contract



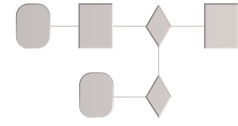
decoupled service
contract accessed
via a uniform
uniform



service
agent



REST service using
uniform contract



process logic



WSDL
definition



XML Schema
definition



general machine
processable
document



human-readable
document
or content



physical
server



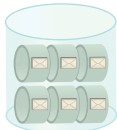
virtual
server



message



security element
or locked resource



message
queue



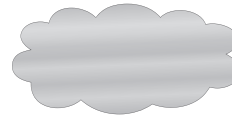
repository
or registry



actively
processing



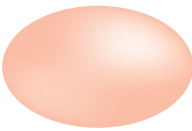
process step or
project/lifecycle stage



Internet



cloud



zone or
region



conflict
symbol



transition
arrow



human
or role



client
workstation



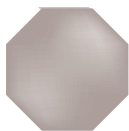
user
interface



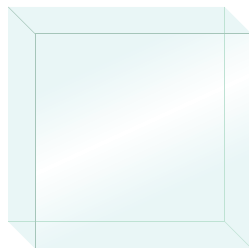
mobile
device



product
or system



symbols used in conceptual
relationship diagrams



general physical
boundary



service inventory
boundary



service
boundary



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Chapter 1

Introduction

- 1.1 About this Book
- 1.2 Recommended Reading
- 1.3 How this Book is Organized
- 1.4 Conventions
- 1.5 Additional Information





The World Wide Web is based on the most successful technology architecture in the history of IT. It has changed how we view, access, and exchange information and, with the formalization of REST constraints, it has also provided us with compelling new ways to build and improve automation solutions.

How you wield the power that comes with the inherent flexibility and simplicity of REST is up to you. REST provides a great deal of guidance for making an architecture and its automation logic technically sound, but it does not provide guidance to ensure that what you build actually provides on-going value in support of the distinct requirements and goals of your business.

Service-orientation has established a proven method for realizing a specific target state. This target state provides proven strategic business value to many organizations. Achieving this target state requires that we apply service-orientation to a suitable distributed computing medium. This book not only demonstrates that REST is a suitable medium for building service-oriented solutions, but also that the service-oriented architectural model is a suitable (and often necessary) foundation for REST-style technology architectures to realize their full business potential.

1.1 About this Book

The purpose of this book is to document how REST relates to and can be used in conjunction with service-oriented architecture, service-orientation design principles, and associated design patterns.

Who this Book is For

- Architects that design services and distributed solution architectures.
- Developers interested in working with REST technologies to build service-oriented solutions.
- Enterprise architects who need to understand the benefits and impacts of REST as a service implementation medium for SOA.





1.2 Recommended Reading

3

- Analysts who may need to model services specifically for eventual implementation as REST services.
- REST specialists who want to understand how REST can be used in support of SOA and service-orientation.
- SOA specialists who want to understand the pros and cons of merging REST architecture with service-oriented architecture.

What this Book Does Not Cover

This is neither a REST tutorial, nor a comprehensive guide to learning SOA or service-orientation. Although introductory chapters cover some fundamentals, the bulk of this book is dedicated to exploring how service-orientation can be applied to REST service design and how REST architecture influences service-oriented solution design and the complexion of service-oriented technology architectures.

This book maintains a focus on modeling, design, and architecture in relation to principles, patterns, and constraints. It does not explore the hands-on implementation of REST-based service architectures in any great detail, nor does it cover middleware and intermediary components, such as proxies and gateways.

If you are new to REST and/or SOA, it is recommended you explore the resources listed in the upcoming *Recommended Reading* section prior to reading this book.

1.2 Recommended Reading

To further ensure that you have a clear understanding of the key terms used and referenced in the upcoming chapters, you can also visit the online master glossary for this book series at www.soaglossary.com.

Books from this series that elaborate on key topics covered by this title include:

- *SOA Principles of Service Design* – A comprehensive documentation of the service-orientation design paradigm with full descriptions of all of the principles referenced in this book. These principles are also explained at www.soapprinciples.com and in Appendix D.
- *SOA Design Patterns* – This is the official SOA design patterns catalog containing descriptions and examples for most of the patterns referenced in this book. You can also look up concise descriptions for these patterns at www.soapatterns.org and in Appendix E.



Further examples of REST service technologies and designs developed in support of service-orientation are provided in the *SOA with .NET & Windows Azure*, *SOA with Java*, and *Service-Oriented Infrastructure: On Premise and in the Cloud* books.

For those of you interested in comparing REST service design to Web service design, the series title *Web Service Contract Design & Versioning for SOA* provides a large amount of corresponding coverage, as it pertains to WSDL, SOAP, XML Schema, WS-Policy, and WS-Addressing.

For those of you new to REST, the following titles are recommended:

- *Building Hypermedia APIs with HTML5 and Node* (by Mike Amundsen, O'Reilly Media, 2011)
- *RESTful Web Services: Web Services for the Real World* (by Leonard Richardson and Sam Ruby, O'Reilly Media, 2007)
- *HTTP: The Definitive Guide* (by David Gourley, O'Reilly Media, 2002)
- *REST in Practice: Hypermedia and Systems Architecture* (by Savas Parastatidis, Ian Robinson, Jim Webber, O'Reilly Media, 2010)
- *Restlet in Action: Developing RESTful Web APIs in Java* (by Jerome Louvel, Thierry Templier, and Thierry Boileau, O'Reilly Media, 2009)
- *RESTful .NET* (by Jon Flanders, O'Reilly Media, 2008)

A number of recommended reading resources for REST are provided in Appendix H, including books, papers, and articles from the authors of this book.

1.3 How this Book is Organized

This book begins with Chapters 1 and 2, which supply introductory content and case study background information respectively. Provided here is a brief overview of subsequent chapters.

Part I: Fundamentals

Chapter 3: Introduction to Services

Service-related terminology and concepts can differ in relation to REST and SOA. This chapter provides a gentle introduction to services and includes clarifications necessary to avoid confusion in subsequent chapters.



1.3 How this Book is Organized

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Chapter 4: SOA Terminology and Concepts

This chapter contains an overview of key terms and concepts associated with SOA, service-orientation, and related topic areas, such as service composition.

Chapter 5: REST Constraints and Goals

This chapter provides a brief overview of REST constraints and architectural design goals. For those of you already familiar with REST, be sure to at least read through the Interface constraint description to understand how this book uses the term “Uniform Contract” for this constraint instead.

Part II: RESTful Service-Orientation

Chapter 6: Service Contracts with REST

Building upon Chapters 3, 4, and 5, this chapter explores the fundamentals of REST service contracts and compares their characteristics and usage to non-REST variations. Also introduced is a distinct diagram symbol notation used to represent REST service contracts and service capabilities.

Chapter 7: Service-Orientation with REST

This chapter includes sections that map service-orientation design principles to REST constraints and architectural properties, and then further explores how REST can impact the goals of service-oriented computing.

Part III: Service-Oriented Analysis and Design with REST

Chapter 8: Mainstream SOA Methodology and REST

A brief introduction to the SOA project delivery phases is provided, along with content relating key stages to REST.

Chapter 9: Analysis and Service Modeling with REST

The complete service-oriented analysis process is explored, with case study examples and augmented for the modeling of REST-based service candidates, service capability candidates, and service composition candidates.



Chapter 10: Service-Oriented Design with REST

A varied collection of design-related topics is provided in this chapter to provide guidance for the creation of custom REST-based service contracts.

Part IV: Service Composition with REST*Chapter 11: Fundamental Service Composition with REST*

The unique design considerations that come with building service compositions comprised of REST services are addressed by a set of topics that tackle areas such as service models, service layers, and idempotency. The chapter concludes with a step-by-step sample scenario.

Chapter 12: Advanced Service Composition with REST

Some of the more challenging areas of REST-based service composition are covered in this dense chapter, including cross-service transactions, event-driven messaging, dynamic binding, and cross-service inventory interactions. A recurring theme throughout this chapter is compliance issues with the Stateless {395} constraint.

Chapter 13: Service Composition with REST Case Study

The services modeled and designed in the case study examples from Chapters 9 and 10 are now aggregated into a REST-based service composition architecture. This in-depth case study steps through two runtime scenarios and maps automated actions to original business process steps.

Part V: Supplemental*Chapter 14: Design Patterns for SOA with REST*

This important chapter provides plain English descriptions of the seven new REST-inspired SOA design patterns that have been added to the SOA design patterns catalog. Each of the explained patterns is officially represented via a profile in Appendix E.

Chapter 15: Service Versioning with REST

This chapter uses some basic versioning content from the series title *Web Service Contract Design & Versioning for SOA* and supplements it with REST service versioning topics and examples.



1.3 How this Book is Organized

7

Chapter 16: Uniform Contract Profiles

The uniform contract profile template is introduced, along with content describing a variation of the established service profile augmented to document REST service characteristics. The chapter concludes with a case study example in which a sample uniform contract profile is documented.

Part VI: Appendices

Appendix A: Case Study Conclusion

This appendix provides a conclusion of the case study storyline.

Appendix B: Industry Standards Supporting the Web

An overview of industry standards organizations and published specifications relevant to REST are provided in this appendix.

Appendix C: REST Constraints Reference

This appendix provides the profile tables for the REST design constraints referenced in this book.

Appendix D: Service-Oriented Principles Reference

This appendix provides the profile tables (originally from *SOA Principles of Service Design*) for the service-orientation design principles referenced in this book.

Appendix E: SOA Design Patterns Reference

This appendix provides the profile tables for the SOA design patterns referenced in this book, including 14 new REST-inspired design patterns.

Appendix F: State Concepts and Types

Fundamental terms and concepts originally introduced in Chapter 11 of *SOA Principles of Service Design* are provided primarily in support of content in Part IV of this book.

Appendix G: The Annotated SOA Manifesto

This appendix provides the annotated version of the SOA Manifesto declaration, which is also published at www.soa-manifesto.com.





Appendix H: Additional Resources

A list of relevant Web sites and supplementary resources is provided in this final appendix, including a bibliography of additional publications.

1.4 Conventions

Use of the Color Red

Text and code fragments are colored red sporadically throughout this book. Red text is used sparingly within general chapter content to help highlight key statements. Within code samples, fragments are generally colored red when they relate to the preceding description text for the given *Example* section.

Design Constraints, Principles, and Patterns: Page References and Capitalization

Each design constraint, principle, and pattern discussed in this book has a corresponding profile. A profile is a concise definition that summarizes key design aspects and considerations. A primary and on-going topic area of this book is the exploration of how constraints, principles, and patterns relate to and affect each other. You are therefore encouraged to repeatedly refer to the profiles whenever encountering a constraint, principle, or pattern in a context that is unclear to you.

In order to facilitate the quick reference of profiles, a special convention is used. Each principle, pattern, and constraint name is always capitalized and followed by a page number that points to the corresponding profile page. This is a convention that was established by the design patterns community and is further being extended to design principles and design constraints in this book.

All page references point to profile tables located in appendices. The profile tables for constraints are provided in Appendix C, and those for principles and patterns are located in Appendices D and E, respectively.

To maintain an immediately recognizable distinction between constraints, principles, and patterns throughout this book, each uses a different delimiter for page numbers. The page number for each constraint is displayed in curly braces, for each principle it is placed in rounded parentheses, and for patterns, square brackets are used, as follows:





- Constraint Name {page number}
- Principle Name (page number)
- Pattern Name [page number]

For example, the following statement first references a service-orientation design principle, then an SOA design pattern, and finally a REST constraint:

“... the Service Loose Coupling (413) principle is supported via the application of the Decoupled Contract [455] pattern and the Stateless {395} constraint ...”

In this statement, each reference is explicitly qualified as a principle, pattern, or constraint. Most of the references in this book (especially in later chapters) omit this qualifier in order to allow for more concise content.

For example, the preceding statement will more commonly be worded as follows:

“... Service Loose Coupling (413) is supported via the application of Decoupled Contract [455] and Stateless {395} ...”

This wording convention also has origins within the design patterns community. As previously stated, if you run into a reference without an explicit qualifier, use the page number delimiter (parentheses, square brackets, or curly braces) to identify its type (principle, pattern, or constraint).

Design Goals: Capitalization

Both the REST architectural design goals and the strategic goals of service-oriented computing are capitalized throughout this book. This convention is introduced to help distinguish references to design goals, primarily for comparison purposes.

Unlike design constraints, principles, and patterns, design goals do not have profiles. The REST architectural design goals are explained in Chapter 5 and the service-oriented computing design goals are covered in Chapter 4.

Symbol Legend

This book contains a series of diagrams that are referred to as *figures*. The primary symbols used throughout all figures are individually described in the symbol legend located on the inside of the book cover.





1.5 Additional Information

The following sections provide supplementary information and resources for the *Prentice Hall Service Technology Series* from Thomas Erl.

Updates, Errata, and Resources (www.servicetechbooks.com)

Information about other series titles and various supporting resources can be found at www.servicetechbooks.com. You are encouraged to visit this site regularly to check for content changes and corrections.

Master Glossary (www.soaglossary.com)

To avoid content overlap and to ensure constant content currency, the books in this series do not contain glossaries. Instead, a dedicated Web site at www.soaglossary.com provides a master glossary for all series titles. This site continues to grow and expand with new glossary definitions as new series titles are developed and released.

Service-Orientation (www.serviceorientation.com)

This site provide papers, book excerpts, and various content dedicated to describing and defining the service-orientation paradigm, associated principles, and the service-oriented technology architectural model.

What Is REST? (www.whatisrest.com)

This Web site contains excerpts from this book and related content to provide a concise overview of REST architecture and constraints.

Referenced Specifications (www.servicetechspecs.com)

The chapters throughout this book reference various industry specifications and standards. The www.servicetechspecs.com Web site provides a central portal to the original specification documents created and maintained by the primary standards organizations.

The Service Technology Magazine (www.servicetechmag.com)

The Service Technology Magazine (formerly the *SOA Magazine*) is a regular publication provided by Arcitura Education Inc. and Prentice Hall and is officially associated with the *Prentice Hall Service Technology Series* from Thomas Erl. *The Service Technology Magazine*





is dedicated to publishing specialized articles, case studies, and papers by industry experts and professionals.

SOASchool.com® SOA Certified Professional (SOACP)

The SOA Certified Professional curriculum is dedicated to specialized areas of service-oriented architecture and service-orientation, including analysis, architecture, governance, security, .NET development, Java development, and quality assurance.

For more information, visit www.soaschool.com.

CloudSchool.com™ Cloud Certified (CCP) Professional

The Cloud Certified Professional curriculum is dedicated to specialized areas of cloud computing, including technology, architecture, governance, security, and storage.

For more information, visit www.cloudschool.com.

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