

# Service Science: Research and Innovations in the Service Economy

## **Series Editors**

Bill Hefley

Wendy Murphy

More information about this series at <http://www.springer.com/series/8080>

Jorge Marx Gómez • Manuel Mora  
Mahesh S. Raisinghani • Wolfgang Nebel  
Rory V. O'Connor  
Editors

# Engineering and Management of Data Centers

An IT Service Management Approach

 Springer

*Editors*

Jorge Marx Gómez  
Department of Computing Sciences  
Carl von Ossietzky University Oldenburg  
Oldenburg, Germany

Manuel Mora  
Department of Information Systems  
Autonomous University of Aguascalientes  
Aguascalientes, Mexico

Mahesh S. Raisinghani  
College of Business  
Texas Woman's University Denton  
Dallas, Houston  
TX, USA

Wolfgang Nebel  
Department for Computing Science  
Carl von Ossietzky University of Oldenburg  
Oldenburg, Germany

Rory V. O'Connor  
School of Computing  
Dublin City University  
Dublin, Ireland

ISSN 1865-4924                      ISSN 1865-4932 (electronic)  
Service Science: Research and Innovations in the Service Economy  
ISBN 978-3-319-65081-4              ISBN 978-3-319-65082-1 (eBook)  
DOI 10.1007/978-3-319-65082-1

Library of Congress Control Number: 2017956900

© Springer International Publishing AG 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature  
The registered company is Springer International Publishing AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Contents

<b>Foundations of Data Center: Key Concepts and Taxonomies</b> .....	1
Cathleen Carey, Mahesh S. Raisinghani, and Becky White	
<b>ITSDM: A Methodology for IT Services Design</b> .....	15
Manuel Mora, Jorge Marx Gómez, Rory V. O'Connor, and Burkard Meyendriesch	
<b>Using Dashboards to Reach Acceptable Risk in Statistics</b> <b>Data Centers Through Risk Assessment and Impact</b> .....	41
Atif Amin and Raul Valverde	
<b>Risk and Data Center Planning</b> .....	73
Kurt J. Engemann and Holmes E. Miller	
<b>Best Practices in Data Center Management:</b> <b>Case – KIO Networks</b> .....	91
Teresa Lucio-Nieto and Dora Luz González-Bañales	
<b>QoS in NaaS (Network-as-a-Service) Using Software</b> <b>Defined Networking</b> .....	115
Ammar AlSous and Jorge Marx Gómez	
<b>Optimization of Data Center Fault Tolerance Design</b> .....	141
Sascha Bosse and Klaus Turowski	
<b>Energetic Data Center Design Considering Energy</b> <b>Efficiency Improvements During Operation</b> .....	163
Stefan Janacek and Wolfgang Nebel	
<b>Demand-Side Flexibility and Supply-Side Management:</b> <b>The Use Case of Data Centers and Energy Utilities</b> .....	187
Robert Basmadjian, Florian Niedermeier, and Hermann de Meer	
<b>DevOps: Foundations and Its Utilization in Data Center</b> .....	205
Mirna Muñoz and Oswaldo Díaz	

**Sustainable and Resilient Network Infrastructure Design for Cloud Data Centers** ..... 227  
Ritchie Qi, William Liu, Jairo Gutierrez, and Mamta Narang

**Application Software in Cloud-Ready Data Centers: A Survey** ..... 261  
Johannes Hintsch, Ateeq Khan, André Siegling, and Klaus Turowski

# Contributors

**Ammar AlSous** Department of Business Information Systems/Very Large Business Applications (VLBA), Carl von Ossietzky University of Oldenburg, Oldenburg, Germany

**Atif Amin** Dubai Statistics Center, Dubai, United Arab Emirates

**Robert Basmadjian** Department of Computer Science and Mathematics, University of Passau, Passau, Germany

**Sascha Bosse** Magdeburg Research and Competence Cluster for Very Large Business Applications, Faculty of Computer Science, Otto-von-Guericke University Magdeburg, Magdeburg, Germany

**Cathleen Carey** Executive MBA Program, School of Management, Texas Woman's University, Denton, TX, USA

**Oswaldo Díaz** Group of Systems Engineering, National Institute of Statistics and Geography, Mexico

**Kurt J. Engemann** Center for Business Continuity and Risk Management, Iona College, New Rochelle, NY, USA

**Dora Luz González-Bañales** Department of Systems and Computing, Instituto Tecnológico de Durango, Durango, Mexico

**Jairo Gutierrez** Department of Information Technology and Software Engineering, School of Engineering, Computer and Mathematical Sciences, Auckland University of Technology, Auckland, New Zealand

**Johannes Hintsch** Magdeburg Research and Competence Cluster for Very Large Business Applications, Faculty of Computer Science, Otto-von-Guericke University Magdeburg, Magdeburg, Germany

**Stefan Janacek** Smart Resource Integration, OFFIS Institute for Information Technology, Lower Saxony, Germany

**Ateeq Khan** Magdeburg Research and Competence Cluster for Very Large Business Applications, Faculty of Computer Science, Otto-von-Guericke University Magdeburg, Magdeburg, Germany

**William Liu** Department of Information Technology and Software Engineering, School of Engineering, Computer and Mathematical Sciences, Auckland University of Technology, Auckland, New Zealand

**Teresa Lucio-Nieto** Universidad Iberoamericana, ITESM & Universidad Anahuac, Customer Care Associates, Monterrey, Nuevo León, Mexico

**Jorge Marx Gómez** Department of Computing Sciences, Carl von Ossietzky University Oldenburg, Oldenburg, Germany

**Hermann de Meer** Department of Computer Science and Mathematics, University of Passau, Passau, Germany

**Burkard Meyendriesch** IT Services Department, Carl von Ossietzky University Oldenburg, Oldenburg, Germany

**Holmes E. Miller** Department of Accounting, Business, Economics and Finance, Muhlenberg College, Allentown, PA, USA

**Manuel Mora** Department of Information Systems, Autonomous University of Aguascalientes, Aguascalientes, Mexico

**Mirna Muñoz** Mathematic Research Center, Zacatecas, Mexico

**Mamta Narang** Department of Information Technology and Software Engineering, School of Engineering, Computer and Mathematical Sciences, Auckland University of Technology, Auckland, New Zealand

**Wolfgang Nebel** Department of Informatics, Carl von Ossietzky University Oldenburg, Lower Saxony, Germany

**Florian Niedermeier** Department of Computer Science and Mathematics, University of Passau, Passau, Germany

**Rory V. O'Connor** School of Computing, Dublin City University, Glasnevin, Dublin, Ireland

**Ritchie Qi** Department of Information Technology and Software Engineering, School of Engineering, Computer and Mathematical Sciences, Auckland University of Technology, Auckland, New Zealand

**Mahesh S. Raisinghani** College of Business, Texas Woman's University Denton, Dallas, Houston, TX, USA

**André Siegling** Magdeburg Research and Competence Cluster for Very Large Business Applications, Faculty of Computer Science, Otto-von-Guericke University Magdeburg, Magdeburg, Germany

**Klaus Turowski** Magdeburg Research and Competence Cluster for Very Large Business Applications, Faculty of Computer Science, Otto-von-Guericke University Magdeburg, Magdeburg, Germany

**Klaus Turowski** Magdeburg Research and Competence Cluster for Very Large Business Applications, Faculty of Computer Science, Otto-von-Guericke University Magdeburg, Magdeburg, Germany

**Raul Valverde** Department of Supply Chain and Business Technology Management, Concordia University, Montreal, QC, Mexico

CONAIC, Mexico City, Mexico

**Becky White** Executive MBA Program, School of Management, Texas Woman's University, Denton, TX, USA