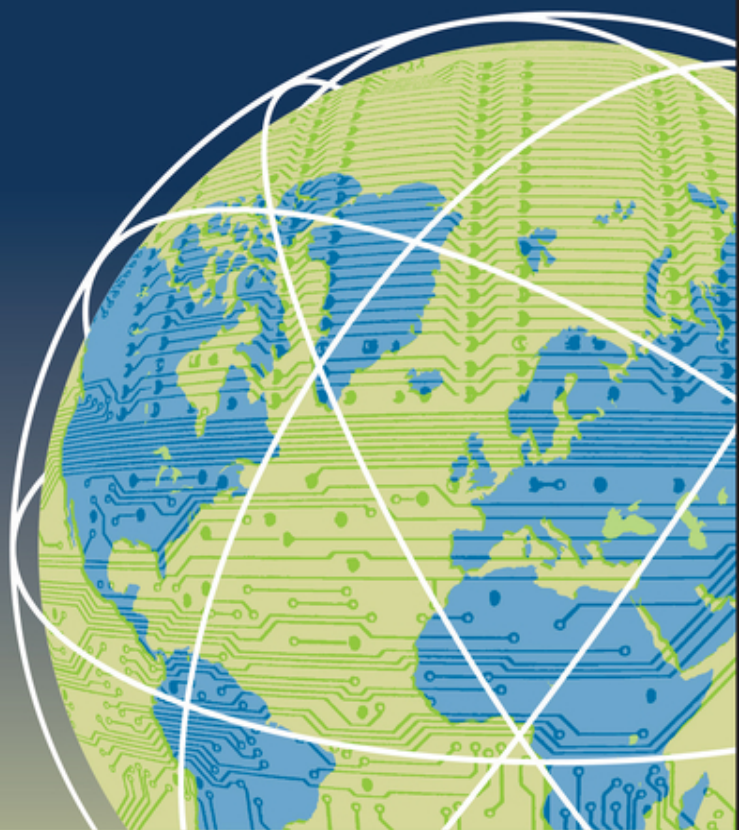


COMMUNICATION NETWORKS AND SERVICE MANAGEMENT IN THE ERA OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Edited by

Nur Zincir-Heywood | Marco Mellia | Yixin Diao




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**IEEE Press Series
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Published by John Wiley & Sons, Inc., Hoboken, New Jersey.
Published simultaneously in Canada.

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Library of Congress Cataloging-in-Publication Data:

Names: Zincir-Heywood, Nur, editor. | Mellia, Marco, editor. | Diao, Yixin, 1970- editor.

Title: Communication networks and service management in the era of artificial intelligence and machine learning / edited by Nur Zincir-Heywood, Marco Mellia, and Yixin Diao.

Description: Hoboken, New Jersey : Wiley-IEEE Press, [2021] | Series: IEEE Press series on networks and service management | Includes bibliographical references and index.

Identifiers: LCCN 2021032407 (print) | LCCN 2021032408 (ebook) | ISBN 9781119675501 (cloth) | ISBN 9781119675440 (adobe pdf) | ISBN 9781119675518 (epub)

Subjects: LCSH: Computer networks. | Artificial intelligence. | Machine learning.

Classification: LCC TK5105.5 .C5998 2021 (print) | LCC TK5105.5 (ebook) | DDC 004.6-dc23

LC record available at <https://lcn.loc.gov/2021032407>

LC ebook record available at <https://lcn.loc.gov/2021032408>

Cover Design: Wiley

Cover Image: © Bill Donnelley/WT Design

Set in 9.5/12.5pt STIXTwoText by Straive, Chennai, India

Contents

Editor Biographies	<i>xv</i>
List of Contributors	<i>xvii</i>
Preface	<i>xxiii</i>
Acknowledgments	<i>xxvii</i>
Acronyms	<i>xxix</i>

Part I Introduction 1

1	Overview of Network and Service Management	3
	<i>Marco Mellia, Nur Zincir-Heywood, and Yixin Diao</i>	
1.1	Network and Service Management at Large	3
1.2	Data Collection and Monitoring Protocols	5
1.2.1	SNMP Protocol Family	5
1.2.2	Syslog Protocol	5
1.2.3	IP Flow Information eXport (IPFIX)	6
1.2.4	IP Performance Metrics (IPPM)	7
1.2.5	Routing Protocols and Monitoring Platforms	8
1.3	Network Configuration Protocol	9
1.3.1	Standard Configuration Protocols and Approaches	9
1.3.2	Proprietary Configuration Protocols	10
1.3.3	Integrated Platforms for Network Monitoring	10
1.4	Novel Solutions and Scenarios	12
1.4.1	Software-Defined Networking – SDN	12
1.4.2	Network Functions Virtualization – NFV	14
	Bibliography	15

- 2 Overview of Artificial Intelligence and Machine Learning 19**
Nur Zincir-Heywood, Marco Mellia, and Yixin Diao
- 2.1 Overview 19
- 2.2 Learning Algorithms 20
 - 2.2.1 Supervised Learning 21
 - 2.2.2 Unsupervised Learning 22
 - 2.2.3 Reinforcement Learning 23
- 2.3 Learning for Network and Service Management 24
- Bibliography 26

Part II Management Models and Frameworks 33

- 3 Managing Virtualized Networks and Services with Machine Learning 35**
Raouf Boutaba, Nashid Shahriar, Mohammad A. Salahuddin, and Noura Limam
- 3.1 Introduction 35
- 3.2 Technology Overview 37
 - 3.2.1 Virtualization of Network Functions 38
 - 3.2.1.1 Resource Partitioning 38
 - 3.2.1.2 Virtualized Network Functions 40
 - 3.2.2 Link Virtualization 41
 - 3.2.2.1 Physical Layer Partitioning 41
 - 3.2.2.2 Virtualization at Higher Layers 42
 - 3.2.3 Network Virtualization 42
 - 3.2.4 Network Slicing 43
 - 3.2.5 Management and Orchestration 44
- 3.3 State-of-the-Art 46
 - 3.3.1 Network Virtualization 46
 - 3.3.2 Network Functions Virtualization 49
 - 3.3.2.1 Placement 49
 - 3.3.2.2 Scaling 52
 - 3.3.3 Network Slicing 55
 - 3.3.3.1 Admission Control 55
 - 3.3.3.2 Resource Allocation 56
- 3.4 Conclusion and Future Direction 59
 - 3.4.1 Intelligent Monitoring 60
 - 3.4.2 Seamless Operation and Maintenance 60
 - 3.4.3 Dynamic Slice Orchestration 61

3.4.4	Automated Failure Management	61
3.4.5	Adaptation and Consolidation of Resources	61
3.4.6	Sensitivity to Heterogeneous Hardware	62
3.4.7	Securing Machine Learning	62
	Bibliography	63
4	Self-Managed 5G Networks	69
	<i>Jorge Martín-Pérez, Lina Magoula, Kiril Antevski, Carlos Guimarães, Jorge Baranda, Carla Fabiana Chiasserini, Andrea Sgambelluri, Chrysa Papagianni, Andrés García-Saavedra, Ricardo Martínez, Francesco Paolucci, Sokratis Barmounakis, Luca Valcarengi, Claudio Ettore Casetti, Xi Li, Carlos J. Bernardos, Danny De Vleeschauwer, Koen De Schepper, Panagiotis Kontopoulos, Nikolaos Koursioupas, Corrado Puligheddu, Josep Manges-Bafalluy, and Engin Zeydan</i>	
4.1	Introduction	69
4.2	Technology Overview	73
4.2.1	RAN Virtualization and Management	73
4.2.2	Network Function Virtualization	75
4.2.3	Data Plane Programmability	76
4.2.4	Programmable Optical Switches	77
4.2.5	Network Data Management	78
4.3	5G Management State-of-the-Art	80
4.3.1	RAN resource management	80
4.3.1.1	Context-Based Clustering and Profiling for User and Network Devices	80
4.3.1.2	Q-Learning Based RAN Resource Allocation	81
4.3.1.3	vrAIn: AI-Assisted Resource Orchestration for Virtualized Radio Access Networks	81
4.3.2	Service Orchestration	83
4.3.3	Data Plane Slicing and Programmable Traffic Management	85
4.3.4	Wavelength Allocation	86
4.3.5	Federation	88
4.4	Conclusions and Future Directions	89
	Bibliography	92
5	AI in 5G Networks: Challenges and Use Cases	101
	<i>Stanislav Lange, Susanna Schwarzmann, Marija Gajić, Thomas Zinner, and Frank A. Kraemer</i>	
5.1	Introduction	101
5.2	Background	103
5.2.1	ML in the Networking Context	103

5.2.2	ML in Virtualized Networks	104
5.2.3	ML for QoE Assessment and Management	104
5.3	Case Studies	105
5.3.1	QoE Estimation and Management	106
5.3.1.1	Main Challenges	107
5.3.1.2	Methodology	108
5.3.1.3	Results and Guidelines	109
5.3.2	Proactive VNF Deployment	110
5.3.2.1	Problem Statement and Main Challenges	111
5.3.2.2	Methodology	112
5.3.2.3	Evaluation Results and Guidelines	113
5.3.3	Multi-service, Multi-domain Interconnect	115
5.4	Conclusions and Future Directions	117
	Bibliography	118

6 Machine Learning for Resource Allocation in Mobile Broadband Networks 123

Sadeq B. Melhem, Arjun Kaushik, Hina Tabassum, and Uyen T. Nguyen

6.1	Introduction	123
6.2	ML in Wireless Networks	124
6.2.1	Supervised ML	124
6.2.1.1	Classification Techniques	125
6.2.1.2	Regression Techniques	125
6.2.2	Unsupervised ML	126
6.2.2.1	Clustering Techniques	126
6.2.2.2	Soft Clustering Techniques	127
6.2.3	Reinforcement Learning	127
6.2.4	Deep Learning	128
6.2.5	Summary	129
6.3	ML-Enabled Resource Allocation	129
6.3.1	Power Control	131
6.3.1.1	Overview	131
6.3.1.2	State-of-the-Art	131
6.3.1.3	Lessons Learnt	132
6.3.2	Scheduling	132
6.3.2.1	Overview	132
6.3.2.2	State-of-the-Art	132
6.3.2.3	Lessons Learnt	134
6.3.3	User Association	134
6.3.3.1	Overview	134
6.3.3.2	State-of-the-Art	136

- 6.3.3.3 Lessons Learnt 136
- 6.3.4 Spectrum Allocation 136
- 6.3.4.1 Overview 136
- 6.3.4.2 State-of-the-Art 138
- 6.3.4.3 Lessons Learnt 138
- 6.4 Conclusion and Future Directions 140
- 6.4.1 Transfer Learning 140
- 6.4.2 Imitation Learning 140
- 6.4.3 Federated-Edge Learning 141
- 6.4.4 Quantum Machine Learning 142
- Bibliography 142

7 Reinforcement Learning for Service Function Chain

Allocation in Fog Computing 147

José Santos, Tim Wauters, Bruno Volckaert, and Filip De Turck

- 7.1 Introduction 147
- 7.2 Technology Overview 148
- 7.2.1 Fog Computing (FC) 149
- 7.2.2 Resource Provisioning 149
- 7.2.3 Service Function Chaining (SFC) 150
- 7.2.4 Micro-service Architecture 150
- 7.2.5 Reinforcement Learning (RL) 151
- 7.3 State-of-the-Art 152
- 7.3.1 Resource Allocation for Fog Computing 152
- 7.3.2 ML Techniques for Resource Allocation 153
- 7.3.3 RL Methods for Resource Allocation 154
- 7.4 A RL Approach for SFC Allocation in Fog Computing 155
- 7.4.1 Problem Formulation 155
- 7.4.2 Observation Space 156
- 7.4.3 Action Space 157
- 7.4.4 Reward Function 158
- 7.4.5 Agent 161
- 7.5 Evaluation Setup 162
- 7.5.1 Fog–Cloud Infrastructure 162
- 7.5.2 Environment Implementation 162
- 7.5.3 Environment Configuration 164
- 7.6 Results 165
- 7.6.1 Static Scenario 165
- 7.6.2 Dynamic Scenario 167
- 7.7 Conclusion and Future Direction 169
- Bibliography 170

Part III Management Functions and Applications 175

- 8 Designing Algorithms for Data-Driven Network Management and Control: State-of-the-Art and Challenges 177**
Andreas Blenk, Patrick Kalmbach, Johannes Zerwas, and Stefan Schmid
- 8.1 Introduction 177
 - 8.1.1 Contributions 179
 - 8.1.2 Exemplary Network Use Case Study 179
 - 8.2 Technology Overview 181
 - 8.2.1 Data-Driven Network Optimization 181
 - 8.2.2 Optimization Problems over Graphs 182
 - 8.2.3 From Graphs to ML/AI Input 184
 - 8.2.4 End-to-End Learning 187
 - 8.3 Data-Driven Algorithm Design: State-of-the Art 188
 - 8.3.1 Data-Driven Optimization in General 188
 - 8.3.2 Data-Driven Network Optimization 190
 - 8.3.3 Non-graph Related Problems 192
 - 8.4 Future Direction 193
 - 8.4.1 Data Production and Collection 193
 - 8.4.2 ML and AI Advanced Algorithms for Network Management with Performance Guarantees 194
 - 8.5 Summary 194
 - Acknowledgments 195
 - Bibliography 195
- 9 AI-Driven Performance Management in Data-Intensive Applications 199**
Ahmad Alnafessah, Gabriele Russo Russo, Valeria Cardellini, Giuliano Casale, and Francesco Lo Presti
- 9.1 Introduction 199
 - 9.2 Data-Processing Frameworks 200
 - 9.2.1 Apache Storm 200
 - 9.2.2 Hadoop MapReduce 201
 - 9.2.3 Apache Spark 202
 - 9.2.4 Apache Flink 202
 - 9.3 State-of-the-Art 203
 - 9.3.1 Optimal Configuration 203
 - 9.3.1.1 Traditional Approaches 203
 - 9.3.1.2 AI Approaches 204
 - 9.3.1.3 Example: AI-Based Optimal Configuration 206

9.3.2	Performance Anomaly Detection	207
9.3.2.1	Traditional Approaches	208
9.3.2.2	AI Approaches	208
9.3.2.3	Example: ANNs-Based Anomaly Detection	210
9.3.3	Load Prediction	211
9.3.3.1	Traditional Approaches	212
9.3.3.2	AI Approaches	212
9.3.4	Scaling Techniques	213
9.3.4.1	Traditional Approaches	213
9.3.4.2	AI Approaches	214
9.3.5	Example: RL-Based Auto-scaling Policies	214
9.4	Conclusion and Future Direction	216
	Bibliography	217
10	Datacenter Traffic Optimization with Deep Reinforcement Learning	223
	<i>Li Chen, Justinas Lingys, Kai Chen, and Xudong Liao</i>	
10.1	Introduction	223
10.2	Technology Overview	225
10.2.1	Deep Reinforcement Learning (DRL)	226
10.2.2	Applying ML to Networks	227
10.2.3	Traffic Optimization Approaches in Datacenter	229
10.2.4	Example: DRL for Flow Scheduling	230
10.2.4.1	Flow Scheduling Problem	230
10.2.4.2	DRL Formulation	230
10.2.4.3	DRL Algorithm	231
10.3	State-of-the-Art: AuTO Design	231
10.3.1	Problem Identified	231
10.3.2	Overview	232
10.3.3	Peripheral System	233
10.3.3.1	Enforcement Module	233
10.3.3.2	Monitoring Module	234
10.3.4	Central System	234
10.3.5	DRL Formulations and Solutions	235
10.3.5.1	Optimizing MLFQ Thresholds	235
10.3.5.2	Optimizing Long Flows	239
10.4	Implementation	239
10.4.1	Peripheral System	239
10.4.1.1	Monitoring Module (MM):	240
10.4.1.2	Enforcement Module (EM):	240

- 10.4.2 Central System 241
 - 10.4.2.1 sRLA 241
 - 10.4.2.2 IRLA 242
- 10.5 Experimental Results 242
 - 10.5.1 Setting 243
 - 10.5.2 Comparison Targets 244
 - 10.5.3 Experiments 244
 - 10.5.3.1 Homogeneous Traffic 244
 - 10.5.3.2 Spatially Heterogeneous Traffic 245
 - 10.5.3.3 Temporally and Spatially Heterogeneous Traffic 246
 - 10.5.4 Deep Dive 247
 - 10.5.4.1 Optimizing MLFQ Thresholds using DRL 247
 - 10.5.4.2 Optimizing Long Flows using DRL 248
 - 10.5.4.3 System Overhead 249
- 10.6 Conclusion and Future Directions 251
 - Bibliography 253

- 11 The New Abnormal: Network Anomalies in the AI Era 261**
Francesca Soro, Thomas Favale, Danilo Giordano, Luca Vassio, Zied Ben Houidi, and Idilio Drago
- 11.1 Introduction 261
- 11.2 Definitions and Classic Approaches 262
 - 11.2.1 Definitions 263
 - 11.2.2 Anomaly Detection: A Taxonomy 263
 - 11.2.3 Problem Characteristics 264
 - 11.2.4 Classic Approaches 266
- 11.3 AI and Anomaly Detection 267
 - 11.3.1 Methodology 267
 - 11.3.2 Deep Neural Networks 268
 - 11.3.3 Representation Learning 270
 - 11.3.4 Autoencoders 271
 - 11.3.5 Generative Adversarial Networks 272
 - 11.3.6 Reinforcement Learning 274
 - 11.3.7 Summary and Takeaways 275
- 11.4 Technology Overview 277
 - 11.4.1 Production-Ready Tools 277
 - 11.4.2 Research Alternatives 279
 - 11.4.3 Summary and Takeaways 280
- 11.5 Conclusions and Future Directions 282
 - Bibliography 283

12	Automated Orchestration of Security Chains Driven by Process Learning	289
	<i>Nicolas Schnepf, Rémi Badonnel, Abdelkader Lahmadi, and Stephan Merz</i>	
12.1	Introduction	289
12.2	Related Work	290
12.2.1	Chains of Security Functions	291
12.2.2	Formal Verification of Networking Policies	292
12.3	Background	294
12.3.1	Flow-Based Detection of Attacks	294
12.3.2	Programming SDN Controllers	295
12.4	Orchestration of Security Chains	296
12.5	Learning Network Interactions	298
12.6	Synthesizing Security Chains	301
12.7	Verifying Correctness of Chains	306
12.7.1	Packet Routing	306
12.7.2	Shadowing Freedom and Consistency	306
12.8	Optimizing Security Chains	308
12.9	Performance Evaluation	311
12.9.1	Complexity of Security Chains	312
12.9.2	Response Times	313
12.9.3	Accuracy of Security Chains	313
12.9.4	Overhead Incurred by Deploying Security Chains	314
12.10	Conclusions	315
	Bibliography	316
13	Architectures for Blockchain-IoT Integration	321
	<i>Sina Rafati Niya, Eryk Schiller, and Burkhard Stiller</i>	
13.1	Introduction	321
13.1.1	Blockchain Basics	323
13.1.2	Internet-of-Things (IoT) Basics	324
13.2	Blockchain-IoT Integration (BIoT)	325
13.2.1	BIoT Potentials	326
13.2.2	BIoT Use Cases	328
13.2.3	BIoT Challenges	329
13.2.3.1	Scalability	332
13.2.3.2	Security	333
13.2.3.3	Energy Efficiency	334
13.2.3.4	Manageability	335
13.3	BIoT Architectures	335
13.3.1	Cloud, Fog, and Edge-Based Architectures	337

13.3.2	Software-Defined Architectures	337
13.3.3	A Potential Standard BIoT Architecture	338
13.4	Summary and Considerations	341
	Bibliography	342
	Index	345

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Preface

Advances in artificial intelligence and machine learning algorithms provide endless possibilities in many different science and engineering disciplines including computer communication networks. Research is therefore needed to understand and improve the potential and suitability of artificial intelligence and machine learning in general for communications and networking technologies and research, but also in particular systems and networks operations and management. Approaches and techniques such as artificial intelligence, data mining, statistical analysis, and machine learning are promising mechanisms to harness the immense stream of operational data in order to improve the management and security of IT systems and networks. This will not only provide deeper understanding and better decision-making based on largely collected and available operational data but will also present opportunities for improving data analysis algorithms and methods on aspects such as accuracy, scalability, and generalization.

This book will focus on recent, emerging approaches, and technical solutions that can exploit artificial intelligence, machine learning, and big data analytics for communications networks and service management solutions. In this context, the book is intended to be a reference book for information and communications technology educators, engineers, and professionals, in terms of presenting a picture of the current landscape and discussing the opportunities and challenges of this field for the future. It is not intended as a textbook. Having said this, it can be used as a reference text for related graduate courses or high-level undergraduate courses on topic.

This book is composed of three parts and 13 chapters that provide an in-depth review of current landscape, opportunities, challenges, and improvements created by the artificial intelligence and machine learning techniques for network and service management.

The first part, Introduction, gives a general overview of the network and service management research as well as the artificial intelligence and machine learning techniques.

Chapter 1, Overview of Network and Service Management, outlines the field of network and service management that involve the setup, configuration, administration, and management of networks and associated services to ensure that network resources are effectively made available to customers and consumed as efficiently as possible by applications.

Chapter 2, Overview of Artificial Intelligence and Machine Learning, overviews the AI/ML algorithms that are most commonly used in the network and service management field, and discusses the strategic areas within network and services management that evidence growing interest of the community in developing cutting edge AI/ML solutions.

The second part of the book, Management Models and Frameworks, is dedicated to important management models and frameworks such as virtualized networks, 5G networks, and fog computing.

Chapter 3, Managing Virtualized Networks and Services with Machine Learning, exposes the state-of-the-art research that leverages Artificial Intelligence and Machine Learning to address complex problems in deploying and managing virtualized networks and services. It also delineates open, prominent research challenges and opportunities to realize automated management of virtualized networks and services.

Chapter 4, Self-Managed 5G Networks, discusses the main challenges that must be faced to successfully develop 5G systems, focusing particularly on radio access networks, optical networks, data plane management, network slicing, and service orchestration, and highlights autonomous data-driven network management and federation among administrative domains that are critical for the development of 5G-and-beyond systems.

Chapter 5, AI in 5G Networks: Challenges and Use Cases, covers three representative case studies including QoE assessment, deployment of virtualized network functions, and slice management. It further points out general and use case-specific requirements and challenges and derives guidelines for network operators who plan to deploy such mechanisms.

Chapter 6, Machine Learning for Resource Allocation in Mobile Broadband Networks, provides an in-depth review of the existing machine learning techniques that have been applied to wireless networks in the context of wireless spectrum and power allocations, user scheduling, and user association.

Chapter 7, Reinforcement Learning for Service Function Chain Allocation in Fog Computing, explores the use of reinforcement learning as an efficient and scalable solution for service function chaining, especially given the dynamic

behavior of the network and the need for efficient scheduling strategies, as compared to the state-of-the-art integer linear programming-based implementations.

The third part of the book, Management Functions and Applications, is focused on vital management function and applications including performance management, security management, and Blockchain applications.

Chapter 8, Designing Algorithms for Data-Driven Network Management and Control: State-of-the-Art and Challenges, provides an overview of approaches that use machine learning and artificial intelligence to learn from problem solution pairs to improve network algorithms. It discusses the applicability for different use cases and identifies research challenges within those use cases.

Chapter 9, AI-Driven Performance Management in Data-Intensive Applications, overviews recurring performance management activities for data-intensive applications and examines the role that AI and machine learning are playing in enhancing configuration optimization, performance anomaly detection, load forecasting, and auto-scaling of software systems.

Chapter 10, Datacenter Traffic Optimization with Deep Reinforcement Learning, develops a two-level deep reinforcement learning system as a scalable end-to-end traffic optimization system that can collect network information, learn from past decisions, and perform actions to achieve operator-defined goals.

Chapter 11, The New Abnormal: Network Anomalies in the AI Era, summarizes recent developments on how AI algorithms bring new possibilities for anomaly detection, and discusses new representation learning techniques such as Generative Artificial Networks and Autoencoders, and new techniques such as reinforcement learning that can be used to improve models learned with machine learning algorithms.

Chapter 12, Automated Orchestration of Security Chains Driven by Process Learning, describes an automated orchestration methodology for security chains in order to secure connected devices and their applications and illustrates how it could be used for protecting Android devices by relying on software-defined networks.

Chapter 13, Architectures for Blockchain-IoT Integration, focuses on defining and determining measures and criteria to be met for an efficient Blockchain and Internet-of-Things integration. It discusses the integration incentives and suitable use cases, as well as the dedicated metrics for scalability, security, and energy efficiency.

New York

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Acknowledgments

We sincerely thank all authors for their contributions. This book would not have been possible without their support and sharing of long-time expertise to benefit the broader audience of this book. We are especially thankful to our Book Series Editors Dr. Mehmet Ulema and Dr. Veli Sahin for inspiring us to start this book project and for providing enthusiastic support throughout. Last but certainly not least, we want to express our sincere gratitude to IEEE – Wiley editors Mary Hatcher, Teresa Netzler, and Victoria Bradshaw for their countless effort to make this book become a reality.

