Preface

The Internet of Things (IoT) paradigm promises to make "things" including consumer electronic devices or home appliances such as medical devices, fridge, cameras, and sensors part of the Internet environment. This paradigm opens the doors to new innovations that will build novel type of interactions among things and humans and enables the realization of smart cities, infrastructures, and services for enhancing the quality of life and utilization of resources.

Internet of Things as an emerging paradigm supports integration, transfer, and analytics of data generated by smart devices (e.g. sensors). IoT envisions a new world of connected devices and humans in which quality of life is enhanced, because management of city and its infrastructure is less cumbersome, health services are conveniently accessible, and disaster recovery is more efficient. Based on bottom-up analysis for IoT applications, McKinsey estimates that the IoT has a potential economic impact of $11 trillion per year by 2025—which would be equivalent to about 11 percent of the world economy. They also expect one trillion IoT devices will be deployed by 2025. In majority of IoT domains such as infrastructure management and healthcare, the major role of IoT is delivery of highly complex knowledge-based and action-oriented applications in real-time.

To realize the full potential of IoT paradigm, it is necessary to address several challenges and develop suitable conceptual and technological solutions for tackling them. These include development of scalable architecture, moving from closed systems to open systems, dealing with privacy and ethical issues involved in data sensing, storage, processing, and actions, designing interaction protocols, and autonomic management, communication protocol, smart objects and service discovery, programming framework, resource management, data and network management, power and energy management, and governance.

The primary purpose of this book is to capture the state-of-the-art in Internet of Things, its applications, architectures, and technologies that address abovementioned challenges. The book also aims to identify potential research directions and technologies that will facilitate insight generation in various domains from science, industry, business, and consumer applications. We expect the book to serve as a reference for systems architects, practitioners, developers, researchers and graduate level students.

Organization of the book

This book contains chapters authored by several leading experts in the field of Internet of Things. The book is presented in a coordinated and integrated manner starting with the fundamentals, and followed by the technologies that implement them. The content of the book is organised into five parts:

I. IoT Ecosystem Concepts and Architectures
II. IoT Enablers and Solutions
III. IoT Data and Knowledge Management
IV. IoT Reliability, Security and Privacy
V. IoT Applications

Part I presents overview of IoT and its related concepts and evolution through time. It throws light upon different IoT architectures and their components and discusses emerging paradigms such as Fog computing. In addition, essential element of a cloud computing infrastructure for IoT services is discussed and a novel framework for collaborative computing between IoT devices and cloud is presented.

Part II is dedicated to platforms and solutions supporting development and deployment of IoT applications. It covers embedded systems programming languages as they play an important role in the development of IoT. Moreover, this part provides an elaborate introduction to message passing mechanisms such as RPC, REST, and CoAP that are indispensable for distributed programming in IoT. Furthermore, techniques for resource sharing and partitioning to enable multi-tenancy are explored. Three basic virtualization techniques for embedded systems are considered: full virtualization, para-virtualization (as instances of hardware-level virtualization), and containers (as instance of operating system level virtualization). Besides, it introduces an architecture which

utilizes both cloud and virtualization for effective deployment of Cyber Physical Systems.

Part III focuses on data and knowledge management which always have been an integral part of IoT applications. It explains how stream processing toolkits offer scalable and reliable solution to handle large volume of data in motion and how they can be utilized in IoT environments. Furthermore, this part introduces a framework for distributed data analysis (machine learning mechanism) based on the core idea of Fog computing to use local resources to reduce the overhead of centralized data collection and processing. It will explain how this can be achieved by learning local models of the data at the nodes, which are then aggregated to construct a global model at a central node.

Part IV presents an argument for developing a governance framework for tackling the data confidentiality, data integrity, and operation control issues faced by IoT. It outlines the organizational, structural, regulatory and legal issues that are commonly encountered in IoT environment. In addition, it provides a detailed overview of the security challenges related to the deployment of smart objects. Security protocols at the network, transport, and application layers are discussed, together with lightweight cryptographic algorithms to be used instead of conventional and demanding ones, in terms of computational resources. Many of IoT applications are business critical, and require the underlying technology to be dependable, i.e. it must deliver its service even in the presence of failures. Therefore, this part discusses the notion of reliability and recovery oriented systems in general and then explains why this is important for an IoT based system. A range of failure scenarios and reliability challenges are narrated and tackled by failure-prevention and fault-tolerance approaches to make an IoT based system robust.

Part V introduces number of applications that have been made feasible by the emergence of Internet of Things. Best practices for architecting IoT application are covered, describing how to harness the power of cutting edge technologies for designing and building a weather station with over 10 sensors using a variety of electronic interfaces connected to an embedded system gateway running Linux. This part also introduces Internet of Vehicles (IoV) and its applications. It starts by presenting the background, concept and network architecture of IoV, and then analyzes the characteristics of IoV and correspondingly new challenges in IoV research and development. Finally, this part discusses role of IoT in enabling efficient management of smart facilities and presents architecture for a cloud-based platform for managing smart facilities and the underlying middleware services. Techniques for effective management of resources in sensor networks and in parallel systems performing data analytics on data collected on a facility are discussed.

Acknowledgments

First and foremost, we are grateful to all the contributing authors for their time, effort, and understanding during the preparation of the book.

Raj would like to thank his family members, especially his wife, Smrithi and daughters, Soumya and Radha Buyya, for their love, understanding, and support during the preparation of the book. Amir would like to thank his wife Elly and daughter Diana.

Finally, we would like to thank the staff at Morgan Kauffman, particularly, Amy Invernizzi, Brian Romer, and Todd Green. They were wonderful to work with

Rajkumar Buyya

The University of Melbourne and Manjrasoft Pty Ltd, Australia

Amir Vahid Dastjerdi

The University of Melbourne, Australia

 First published in 2006 by PALGRAVE MACMILLANâ„¢ 175 Fifth Avenue, New York, N.Y. 10010 and Houndmills, Basingstoke, Hampshire, England RG21 6XS.Â This is not a book about international organizations (IOs). Nor is it a book about global governance. It is a book about IO theory, and about the use of this theory to understand international relations. It does not attempt to systematically review the world of IOs or to comprehensively describe the UN or any other particular organ-ization. Learn more about organizational culture with these books. Have you ever wondered how organizational development can help your firm or do you want to know what a manager actually does? This series of books will answer these questions in an entertaining and concise manner.Â Organizational culture & development. Learn more about organizational culture with these books. Have you ever wondered how organizational development can help your firm or do you want to know what a manager actually does? This series of books will answer these questions in an entertaining and concise manner.