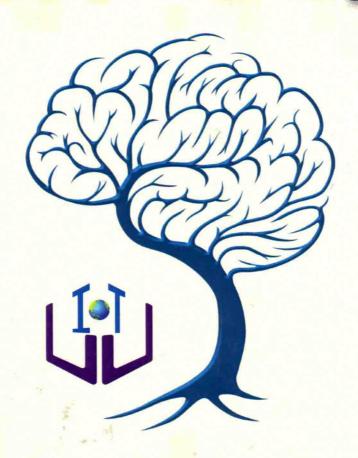
Unit and Ubiquitous Internet of Things



Huansheng Ning



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Preface

Internet of Things (IoT) attracts great attention, and brings promising opportunities and challenges. Research on IoT has important economic and social values for developing the next generation of information, network, and communication technologies. However, it is still confusing for most people to understand IoT well, including definitions, content, and differences from other similar concepts.

IoT connects and fuses the physical world and cyber world by ubiquitous sensing, connection, and control with definite social attributes. It is hopeful that IoT can emancipate humans from onerous human-machine interface work and information exploration.

This book attempts to provide a future IoT vision, and answer some fundamental questions from various aspects, including concepts, architectures, models, and key technologies. It aims to help readers discover the fundamental issues in IoT, and to be a valuable IoT literature for college students, practicing engineers, researchers, business operators, and policy makers.

The book accomplishes three main objectives:

Introduces IoT essential concepts and content from the perspectives of mapping and interaction between the physical world and cyber world. Meanwhile, social attributes are emphatically discussed in IoT.

- Builds a fundamental architecture for future IoT, based on the IoT layered model, topological structure, various existence forms, and corresponding logical relationships are described. Specific case studies are also presented in different application scenarios.
- Establishes an IoT technology system based on the knowledge of IoT scientific problems, and gives an overview for core technologies, including basic connotation, development status, and open challenges.

Accordingly, this book is organized in three main parts.

Chapter 1 introduces the basic IoT concept, the intrinsic characteristics of IoT, IoT development and applications, and future IoT vision, which helps readers get an overall understanding on IoT.

The next section includes Chapters 2 to 4. Chapter 2 discusses IoT architecture and fundamentals, including the main aspects of architecture, layered models, IoT development phases, the science category, and supporting technologies. Here, unit and ubiquitous IoT (U2IoT) architecture and a six-layer model are designed for future IoT. Unit IoT and ubiquitous IoT are respectively introduced in Chapters 3 and 4. Concretely, Chapter 3 introduces ubiquitous sensing, networking and communications, and information management involved in unit IoT, and presents several typical application scenarios. Chapter 4 illustrates ubiquitous IoT, including local IoT, industrial IoT, national IoT, transnational IoT, and global application IoT by analyzing their concepts, characteristics, and some typical cases.

Chapters 5 to 14 compose the last section, in which 10 main supporting technologies are respectively discussed: resource management, loop control in actuation, session management, space-time consistency, security and privacy, energy management, spectrum management, nanotechnology, quantum technology, and big data.

About the Author

Huansheng Ning, Ph.D., is an associate professor in the School of Electronic and Information Engineering, Beihang University. He was born in Anhui, China, and received a B.S. from Anhui University, China, and a Ph.D. from Beihang University, China. From 2002 to 2003, Dr. Ning worked at Aisino Corporation, Beijing, China. From 2004 to 2005, he was a post-Ph.D. at Beihang University. He has presided over several research projects supported by the National Natural Science Foundation of China (NSFC), the National High Technology Research and Development Program of China (863 Program), and other organizations. He has published many papers and books on radio frequency identification (RFID) and Internet of Things (IoT). Dr. Ning serves as an editor on Advances in Internet of Things (2012-Present), is a guest editor for the Journal of Universal Computer Science Special Issue on Internet of Things (JUCS), and coeditor for The Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems (Taylor & Francis Group). He also serves as a chair or program committee member for international conferences/workshops, for example, program chair (IEEE iThings 2012), program committee member (AMT 2012),

Internet of Things and CPS track chair (IEEE CIT'12), workshop chair (IEEE iThings 2011), and general chair (UMES 2011). Dr. Ning's current research focuses on Internet of Things, electromagnetic sensing, and aviation security.

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INTRODUCTION

Internet of Things (IoT) attracts great attention, and brings with it promising opportunities and challenges. Research on IoT has important economic and social value for the development of the next generation of information, network, and communication technologies. To introduce IoT, four aspects are discussed: the concept of IoT, the intrinsic characteristics of IoT, IoT development and application, and the vision for the future of IoT.

1.1 IoT Concept

The phrase "Internet of Things" was proposed by MIT Auto-ID Center in 1999 [1]. Such an embryonic definition of IoT refers to constructing an Internet-based network covering all the things in the world by using related technologies (e.g., radio frequency identification [RFID]) to realize things' automatic identification and information sharing. In 2005, ITU Internet Reports 2005: The Internet of Things, published by the International Telecommunications Union [2], pointed out the IoT concept and expanded its meaning, and indicated that RFID technology, sensor technology, nanotechnology, and intelligent embedded technology are the four core technologies to realize IoT. After IBM announced the SmartPlanet concept in 2009, IoT became a hot topic and has been incorporated into many nations' development strategies. Along with the changes of application requirements and technology development, the IoT concept has been rapidly extended and new technologies have been involved in it.

In recent years, IoT has been redefined depending on different perspectives and application scenarios. The Cluster of European Research Projects on the Internet of Things *Strategic Research Roadmap*, announced by the European Union in 2009 [3], stated that "IoT is an integrated part of Future Internet and could be defined as