

Unit and Ubiquitous Internet of Things



Huansheng Ning



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CRC Press

Taylor & Francis Group

Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

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CRC Press is an imprint of Taylor & Francis Group, an Informa business

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Printed and bound in Great Britain by TJ International, Padstow, Cornwall
Version Date: 20130304

International Standard Book Number-13: 978-1-4665-6166-3 (Hardback)

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Library of Congress Cataloging-in-Publication Data

Ning, Huansheng.
Unit and ubiquitous Internet of things / author, Huansheng Ning.
pages cm
Includes bibliographical references and index.
ISBN 978-1-4665-6166-3 (hardback)
1. Embedded Internet devices. 2. Internet of things. 3. Ubiquitous computing. I.
Title.
TK7895.E43N46 2013
004--dc23
2013002112

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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),

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Acknowledgments

I thank my graduate students, Hong Liu, Sha Hu, Yang Fu, Wei He, Wei Du, and Jun Wang, for their help in preparing this book.

I am also grateful to all the quoted authors and the corresponding publications, and thank IEEE, John Wiley & Sons, and Scientific Research Publishing for permission to reuse the related materials.

Finally, I am very thankful to editor Ruijun He for his guidance and suggestions, and Stephanie Morkert and Linda Leggio for their help in the production of this book.

Contents

PREFACE	xiii
ABOUT THE AUTHOR	xv
ACKNOWLEDGMENTS	xvii
CHAPTER 1 INTRODUCTION	1
1.1 IoT Concept	1
1.2 Related Concepts to IoT	3
1.3 The Intrinsic Characteristics of IoT	5
1.4 IoT Development and Application	6
1.5 Future IoT Vision	8
References	9
CHAPTER 2 ARCHITECTURE AND FUNDAMENTALS	11
2.1 Some Research on IoT Architecture	12
2.2 Ubiquitous IoT (U2IoT) Architecture	13
2.2.1 Unit IoT Definition and Its Architecture	14
2.2.2 Ubiquitous IoT Definition and Its	
Architecture Design	15
2.3 Some Layered Models for IoT	17
2.3.1 Three-Layer Model	17
2.3.2 Four-Layer Model	17
2.3.3 Eight-Layer Model	18
2.3.4 Discussion on the above Layered Models	19
2.4 Layered Model Proposed and Social Attributes	
Discussion for U2IoT	19
2.4.1 Layered Model Designed for U2IoT	19

2.4.2	Layer Description and Social Attributes for Unit IoT	20
2.4.3	Layer Description and Social Attributes for Ubiquitous IoT	23
2.5	IoT Development Phases Summary and Discussion	26
2.5.1	Early Stage	26
2.5.2	Unit IoT Stage	27
2.5.3	Industrial/Local IoT Stage	27
2.5.4	National IoT	28
2.6	Science Category and Supporting Technologies for IoT	29
2.6.1	Science Category Based on Cyber-Physical-Social Aspects	29
2.6.2	Supporting Technologies	31
2.7	Conclusion	32
	References	33
CHAPTER 3	UNIT INTERNET OF THINGS	35
3.1	Introduction	35
3.2	Sensors and Actuators	36
3.2.1	Sensors	37
3.2.2	Actuators	38
3.3	Ubiquitous Sensing	39
3.3.1	Radio Frequency Identification (RFID)	40
3.3.2	Bluetooth	41
3.3.3	Wireless Fidelity (Wi-Fi)	42
3.3.4	Ultra-Wideband (UWB)	42
3.3.5	ZigBee	43
3.3.6	Infrared Data Transmission	44
3.4	Networking and Communications	45
3.4.1	Mobile Communication Technology	45
3.4.1.1	Third-Generation Technology (3G)	45
3.4.1.2	Wireless Local Area Network (WLAN)	46
3.4.1.3	Fourth-Generation Technology (4G)	46
3.4.2	Next-Generation Internet Technology	47
3.5	Management and Data Centers (M&DCs)	49
3.5.1	Pervasive Management	49
3.5.1.1	Object/Entity Management	49
3.5.1.2	Network Management	49
3.5.1.3	Service Management	50
3.5.2	Data Fusion and Data Mining	50
3.6	Case Study for Unit IoT	52
3.6.1	Identification	53
3.6.1.1	Asset Management	53
3.6.1.2	Biometrics Identification	55
3.6.1.3	E-Passport	56
3.6.2	Information Aggregation	58

3.6.2.1	Smart Home	58
3.6.2.2	Satellite Remote Sensing System	60
3.6.3	Safety Awareness	62
3.6.3.1	Bird Strike Avoidance Radar System	62
3.6.3.2	River Navigation Safety System	63
3.6.4	Monitoring and Control	65
3.6.4.1	Precision Manufacturing System	65
3.7	Conclusion	66
	References	66
CHAPTER 4	UBIQUITOUS INTERNET OF THINGS	69
4.1	Introduction	69
4.2	Local Internet of Things	70
4.2.1	Local IoT Concept	70
4.2.2	Main Characteristics of Local IoT	72
4.2.3	Case Study: Smart City	73
4.2.4	Case Study: Logistics Network of China Pearl River Delta (PRD)	75
4.3	Industrial Internet of Things	75
4.3.1	Industrial IoT Concept	75
4.3.2	Main Characteristics of Industrial IoT	76
4.3.2.1	Geographical Dispersion	76
4.3.2.2	Multiuser Orientation	76
4.3.3	An Example: A Smart Grid	78
4.4	National Internet of Things	78
4.4.1	National IoT Concept	78
4.4.2	National Development Planning	79
4.4.3	Management of National IoT	80
4.5	Transnational Internet of Things Application	81
4.5.1	Description	81
4.5.2	An Example: Transnational Logistics IoT in ACFTA	81
4.6	Global Application IoT and a Typical Example	82
4.6.1	Description	82
4.6.2	Case Study: Global Logistics IoT	82
4.7	Conclusion and Discussion	86
	References	87
CHAPTER 5	RESOURCE MANAGEMENT	89
5.1	Introduction	89
5.2	Object Coding and Resolving	91
5.2.1	Object Coding Discussion	91
5.2.1.1	Coding for ID Objects	92
5.2.1.2	Coding for nID Objects	92
5.2.1.3	Combined Coding for Objects with ID and nID	93
5.2.2	Resolving Discussion for nID Objects	93

5.2.2.1	Space-Time Information Resolving	94
5.2.2.2	Unique Attributes (UA) Resolving	94
5.2.2.3	Nonunique Attributes (NA) Resolving	94
5.3	Resource Naming	94
5.4	Resource Addressing	98
5.5	Resource Discovery	101
5.6	Resource Allocation	104
5.7	Resource Management Scheme in U2IoT	106
5.7.1	Context Information	106
5.7.2	Resource Management Scheme for U2IoT	109
5.7.2.1	Resource Management in Unit IoT	109
5.7.2.2	Resource Management in Ubiquitous IoT	110
5.8	Conclusion	111
	References	111
CHAPTER 6	LOOP CONTROL IN ACTUATION	115
	References	117
CHAPTER 7	SESSION MANAGEMENT	119
7.1	Introduction	119
7.2	Single-Session Management in IoT	120
7.3	Multiple-Session Management in IoT	120
7.4	Challenges	122
	References	122
CHAPTER 8	SPACE-TIME CONSISTENCY AND LOCATION PRIVACY	123
8.1	Introduction	123
8.2	Space-Time Registration in Unit IoT	125
8.2.1	Time Synchronization	125
8.2.2	Object Localization	126
8.2.3	Time Registration for Unit IoT	127
8.2.4	Space Registration for Unit IoT	127
8.3	Space-Time Registration for Ubiquitous IoT	128
8.3.1	Time Registration for Ubiquitous IoT	128
8.3.2	Space Registration for Ubiquitous IoT	129
8.4	Space-Time Consistency Discussion in U2IoT	129
8.5	A Case Study in an Airport	131
8.6	Location Privacy	133
8.6.1	Main Characteristics of Location Privacy	133
8.6.2	Location Privacy-Preserving Mechanism	134
8.6.2.1	Privacy Policy	134
8.6.2.2	Anonymity and Pseudonymity	135
8.6.2.3	Obfuscation	135
8.6.3	Challenges and Open Issues	136
8.7	Conclusion	136
	References	137

CHAPTER 9	SECURITY AND PRIVACY	139
9.1	Introduction	139
9.2	Security Challenges in U2IoT	140
9.2.1	Security Requirements	140
9.2.1.1	CIA Triad	140
9.2.1.2	Authority	141
9.2.1.3	Nonrepudiation	141
9.2.1.4	Privacy Preservation	141
9.2.2	Security Attacks	142
9.2.2.1	Gathering	142
9.2.2.2	Imitation	142
9.2.2.3	Blocking	143
9.2.2.4	Privacy Disclosure	143
9.3	The Security Framework for U2IoT	145
9.3.1	Information Security	146
9.3.2	Physical Security	147
9.3.3	Management Security	149
9.4	A Proposed Hybrid Authentication and Hierarchical Authorization Scheme	150
9.4.1	The Security Protocol Suite in Unit IoT (UnSPs)	153
9.4.1.1	The In-Group Hybrid Authentication Protocol in UnSPs	153
9.4.1.2	The Out-Group Centralized Authorization Protocol in UnSPs	155
9.4.2	The Security Protocol Suite in Ubiquitous IoT (UbSPs)	157
9.4.2.1	The Centralized Authentication Protocol in UbSPs	157
9.4.2.2	The Distributed Authority Transfer Protocol in UbSPs	158
9.4.2.3	The Centralized Authority Transfer Protocol in UbSPs	160
9.4.2.4	The Distributed Authority Sharing Protocol in UbSPs	161
9.4.3	Security Analysis	163
9.4.3.1	Authentication	163
9.4.3.2	Authorization	163
9.4.3.3	Session Freshness	164
9.4.3.4	Privacy Preservation	164
9.5	Entity Activity Cycle-Based Security Solution	165
9.5.1	In the Preactive Phase	166
9.5.2	In the Active Phase	166
9.5.2.1	Authentication	166
9.5.2.2	Access Control	167
9.5.2.3	Secure Routing	167
9.5.2.4	Advanced Signature	167

9.5.2.5	Zero-Knowledge Proof	168
9.5.2.6	Data Aggregation	168
9.5.3	In the Postactive Phase	169
9.5.3.1	Intrusion Detection	169
9.5.3.2	Intrusion Tolerance and Threshold Cryptography	169
9.6	Conclusion	169
	References	170
CHAPTER 10	ENERGY MANAGEMENT	173
10.1	Introduction	173
10.2	Energy Management in Unit IoT	175
10.2.1	Energy Supply Management in Unit IoT	176
10.2.2	Energy Demand Management in Unit IoT	177
10.2.3	Supply-Demand Balance Management in Unit IoT	180
10.3	Energy Management in Ubiquitous IoT	181
10.4	Conclusion and Discussion	183
	References	184
CHAPTER 11	SPECTRUM MANAGEMENT	187
11.1	Introduction	187
11.2	Spectrum Management System, Equipment, and Technology	188
11.2.1	National Spectrum Management System	189
11.2.2	Spectrum Monitoring and Management Equipment	190
11.2.3	Technological Innovation and Spectrum Management	191
11.3	The Vision, Challenge, and Scheme of Spectrum Management in IoT	192
11.3.1	Spectrum Management Visions and Challenges	192
11.3.2	Spectrum Management Scheme in IoT	194
11.3.2.1	Spectrum Management in Unit IoT	195
11.3.2.2	Spectrum Management in Ubiquitous IoT	196
11.4	Conclusion	199
	References	199
CHAPTER 12	NANOTECHNOLOGY	201
12.1	Introduction	201
12.2	Nanotechnology in Ubiquitous Sensing	201
12.2.1	Nanotechnology-Based New Sensors and Actuators	201
12.2.2	Nanoscale Sensor Networks	202

12.3	Nanotechnology in Communication Networks	203
12.3.1	High-Performance Routing and Switching Devices	204
12.3.2	Radio Frequency (RF) Communication	204
12.4	Nanotechnology in High-Performance Computing	205
	References	207
CHAPTER 13	QUANTUM TECHNOLOGY	209
13.1	Introduction	209
13.2	Quantum Technology: Driving IoT Development	210
13.2.1	Making Sensor Networks More Powerful	211
13.2.2	Making Communication More Secure	211
13.2.3	Making Massive Data Processing More Efficient	212
	References	213
CHAPTER 14	BIG DATA	215
14.1	Introduction	215
14.2	Technology and Application	216
14.2.1	Some Typical Technologies for Big Data	216
14.2.2	Application Platform and Solution	217
14.3	Conclusion	218
	References	218
	Index	221

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