

Table of Contents

Foreword	xi
Guy PUJOLLE	
PART ONE: PHYSICS OF RFID	1
Chapter 1. Introduction	3
Simon ELRHARBI, Stefan BARBU	
1.1. Bibliography	5
Chapter 2. Characteristics of RFID Radio Signals	7
Simon ELRHARBI, Stefan BARBU	
2.1. Description and operating principle of RFID systems	7
2.1.1. Classification of RFID systems	7
2.1.2. Available operating frequency ranges	8
2.1.3. Transponder types	8
2.1.4. Energy and data transmission modes	12
2.1.5. Features of RFID chips	18
2.2. Transmission channel	19
2.2.1. Maxwell's equations	19
2.2.2. Electromagnetic field generated by an electric dipole	20
2.2.3. Electromagnetic field generated by a magnetic dipole	21
2.2.4. Field zones surrounding antennae	22
2.2.5. Wave impedance	24
2.2.6. Antenna impedance	26
2.2.7. Radiated power	26
2.2.8. Near-field coupling	27
2.3. First level electric model in inductive coupling	31
2.3.1. Magnetic loop	32
2.3.2. Base station antenna	33
2.3.3. RFID chip antenna	37

2.3.4. Design issue of RFID antennae in inductive coupling	40
2.3.5. Far field coupling	43
2.4. Bibliography	55
Chapter 3. RFID Communication Modes	57
Simon ELRHARBI, Stefan BARBU	
3.1. Communication modes	57
3.1.1. Waveforms and usual communication codes of RFID systems . .	57
3.1.2. Data coding	58
3.1.3. Modulation	61
3.1.4. Integrity of transmissions in RFID systems	62
3.1.5. Anti-collision protocol	65
3.2. Bibliography	68
PART TWO: RFID APPLICATIONS	69
Chapter 4. Applications	71
François LECOCQ, Cyrille PÉPIN	
4.1. Introduction	71
4.2. History: evolution from barcodes to RFID tags	72
4.2.1. Description of barcodes	72
4.2.2. One-dimensional (or linear) barcodes	73
4.2.3. Stacked linear barcodes	78
4.2.4. Two-dimensional barcodes	80
4.3. RFID tags	83
4.3.1. Characteristics of RFID tags	84
4.3.2. Operating principle	84
4.4. Normalization/standardization	89
4.4.1. ISO standards for RFID	90
4.4.2. ISO standards for middleware	93
4.4.3. User guidance	93
4.4.4. Protocols	94
4.4.5. EPCglobal standards	94
4.4.6. Communication layer	95
4.4.7. Different types of tags	96
4.5. Advantages/disadvantages of RFID tags	98
4.5.1. Advantages	98
4.5.2. Disadvantages	100
4.6. Description of RFID applications	102
4.7. Application examples	103
4.7.1. RFIDs in commerce	103
4.7.2. Access control	105
4.7.3. Culture and RFID	105

4.7.4. Payment	106
4.7.5. RFID and health	107
4.7.6. European biometric passport	109
4.7.7. Future perspectives	109
4.8. Conclusion	109
4.9. Bibliography	111
PART THREE: CRYPTOGRAPHY OF RFID	113
Chapter 5. Cryptography and RFID	115
Julien BRINGER, Hervé CHABANNE, Thomas ICART, Thanh-Hà LE	
5.1. Introduction	115
5.2. Identification protocols and security models	116
5.2.1. Definition of an identification protocol	116
5.2.2. Classical notions of security	117
5.2.3. Privacy notions	118
5.3. Identification protocols	121
5.3.1. Symmetric cryptography-based protocols	122
5.3.2. Asymmetric cryptography-based protocols	129
5.3.3. Protocols based on physical properties	135
5.3.4. Summary	140
5.4. Conclusion. Physical attacks on RFID devices	141
5.4.1. Side-channel attacks	141
5.4.2. Fault injection attacks	143
5.4.3. KeeLoq	143
5.5. Bibliography	144
PART FOUR: EPCGLOBAL	151
Chapter 6. EPCglobal Network	153
Dorice NYAMY, Mathieu BOUET, Daniel DE OLIVEIRA CUNHA, Vincent GUYOT	
6.1. Introduction	153
6.2. Tags	154
6.2.1. EPC codes	154
6.2.2. Classes of tags	158
6.2.3. Standards of tags	160
6.3. EPCglobal architecture	164
6.3.1. Reader protocol	164
6.3.2. Application Level Events (ALE) interface	166
6.3.3. Object Name Service (ONS)	170
6.3.4. Physical Mark-up Language (PML)	173
6.3.5. EPC Information Service interface	175
6.3.6. Security	176

6.4. Conclusion	179
6.5. Bibliography	180
PART FIVE: MIDDLEWARE	183
Chapter 7. Middleware for the Internet of Things: Principles	185
David DURAND, Yann IAGOLNITZER, Patrice KRZANIK, Christophe LOGE, Jean-Ferdinand SUSINI	
7.1. Distributed applications	187
7.1.1. Principles	187
7.1.2. Client-server model	187
7.2. RPC: Remote Procedure Call	188
7.3. Object-oriented middlewares	189
7.3.1. Examples	191
7.4. Summary of object-oriented middleware architectures	195
7.5. The XML revolution	199
7.5.1. Overview of XML	199
7.5.2. Definition of the structure of an XML document	200
7.5.3. Web services	202
7.5.4. Description of Web services-WSDL	203
7.5.5. Location of Web services	206
7.5.6. SOAP	207
7.6. Middleware for the Internet of Things	208
7.6.1. Service-oriented middlewares	209
7.6.2. Data-oriented middleware	211
7.7. Conclusion	213
7.8. Bibliography	213
Chapter 8. Middleware for the Internet of Things: Standards	217
Yann IAGOLNITZER, Patrice KRZANIK, Jean-Ferdinand SUSINI	
8.1. EPCglobal application environment	218
8.2. General introduction to message-oriented middleware	219
8.2.1. General instruction to message-oriented middleware	219
8.2.2. Java Messaging Service (JMS)	221
8.2.3. XMPP	225
8.3. Service-oriented middleware	231
8.3.1. OSGi	231
8.3.2. UPnP	237
8.4. Conclusion	242
8.5. Bibliography	242

Chapter 9. Middleware for the Internet of Things: Some Solutions	245
Yann IAGOLNITZER, Patrice KRZANIK, Jean-Ferdinand SUSINI	
9.1. EPCglobal and SUN Java RFID software	246
9.1.1. Software architecture of SUN Java System RFID	246
9.1.2. Java System RFID event manager	247
9.1.3. Java System RFID information server	249
9.2. .NET and RFID services platform	250
9.2.1. .NET platform	250
9.2.2. Distributed applications - .NET Remoting	252
9.2.3. RFID Service Platform	253
9.3. IBM Websphere RFID Suite	256
9.3.1. Data capture layer	256
9.3.2. Premise servers	257
9.4. Singularity	258
9.4.1. Middleware	258
9.4.2. Hibernate - JBoss	260
9.5. Middleware for embedded systems	260
9.5.1. TinyDB	260
9.5.2. GSN	262
9.6. ObjectWeb projects and the Internet of Things	265
9.6.1. Presentation of ObjectWeb	265
9.6.2. JORAM, component of ObjectWeb RFID	265
9.6.3. Architecture of JORAM	266
9.6.4. Advanced functions of JORAM	266
9.6.5. Ongoing works on JORAM	268
9.6.6. JINI technology and the Internet of Things	268
9.6.7. JONAS, component of ObjectWeb RFID	271
9.6.8. ASPIRE initiative of OW2	273
9.7. Conclusion	276
9.8. Bibliography	276
List of Authors	279
Index	283