APPENDIX C

Apple 1122 (Part 4 of 5) Apple v. USR IPR2018-00813 UMMU TK 5105.59 .B871 2001 bks



ISA Security's Official Guide to CRYPTOGRAPHY

Learn how secure data-encryption techniques work

Protect confidential information on your network

Get official current cryptography standards on enclosed CD-ROM

Steve Burnett & Stephen Paine

RSA Security's Official Guide to Cryptography

Steve Burnett and Stephen Paine

Osborne/**McGraw-Hill** New York Chicago San Francisco Lisbon London Madrid Mexico City Milan New Delhi San Juan Seoul Singapore Sydney Toronto

Osborne/McGraw-Hill 2600 Tenth Street

Berkeley, California 94710 U.S.A.

To arrange bulk purchase discounts for sales promotions, premiums, or fundraisers, please contact Osborne/**McGraw-Hill** at the above address. For information on translations or book distributors outside the U.S.A., please see the International Contact Information page immediately following the index of this book.

RSA Security's Official Guide to Cryptography

Copyright © 2001 by The McGraw-Hill Companies. All rights reserved. Printed in the United States of America. Except as permitted under the Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher, with the exception that the program listings may be entered, stored, and executed in a computer system, but they may not be reproduced for publication.

234567890 FGR FGR 01987654321

Book p/n 0-07-213138-1 and CD p/n 0-07-213137-3 parts of ISBN 0-07-213139-X

Publisher Brandon A. Nordin

Vice President & Associate Publisher Scott Rogers

Executive Editor Steven Elliot

Senior Project Editor LeeAnn Pickrell

Acquisitions Coordinator Alexander Corona Technical Editors Blake Dournaee Jessica Nelson

Copy Editor Betsy Hardinger

Composition and Indexer MacAllister Publishing Services, LLC

Illustrators Michael Mueller Beth Young Lyssa Sieben-Wald

Information has been obtained by Osborne/McGraw-Hill from sources believed to be reliable. However, because of the possibility of human or mechanical error by our sources, Osborne/McGraw-Hill, or others, Osborne/McGraw-Hill does not guarantee the accuracy, adequacy, or completeness of any information and is not responsible for any errors or omissions or the results obtained from use of such information. Umm4/bks 41412416 eltr 8-9-02

> To Pao-Chi, Gwen, Ray, Satomi, Michelle, Alexander, Warren, Maria, Daniel, and Julia

-Steve Burnett

To Danielle, thanks for understanding while I worked on this book

To Alexis and Elizabeth, a father could not ask for better children

-Stephen Paine

Contents

Credits	xiii
Foreword	XV
Acknowledgments	xvii
Preface	xix
About the Authors	xxii
Chapter 1 Why Cryptography?	1
Security Provided by Computer Operating Systems	2
How Operating Systems Work	2
Default OS Security: Permissions	3
Attacks on Passwords	4
Attacks That Bypass Operating Systems	6
Data Recovery Attack	6
Memory Reconstruction Attack	9
Added Protection Through Cryptography	11
The Role of Cryptography in Data Security	12
Chapter 2 Symmetric-Key Cryptography	15
Some Crypto Jargon	18
What Is a Key?	20
Why Is a Key Necessary?	22
Generating a Key	22
A Random Number Generator	27
A Pseudo-Random Number Generator	28
Attacks on Encrypted Data	30
Attacking the Key	30
Breaking the Algorithm	36
Measuring the Time It Takes to Break Your Message	37
Symmetric Algorithms: The Key Table	37
Symmetric Algorithms: Block Versus Stream Ciphers	38
Block Ciphers	38
Stream Ciphers	41
Block Versus Stream: Which Is Better?	45
Digital Encryption Standard	46
Triple DES	47
Commercial DES Replacements	49
Advanced Encryption Standard	50

Summary	51
Real-World Example: Oracle Databases	51
Chapter 3 Symmetric-Key Management	53
Password-Based Encryption	54
Programming Convenience	59
Breaking PBE	63
Slowing Down an Attack on a Password	64
Good Passwords	65
Password Generators	67
Hardware-Based Key Storage	69
Tokens	69
Crypto Accelerators	73
Hardware Devices and Random Numbers	75
Biometrics	75
Summary	76
Real-World Examples	76
Keon Desktop	77
Other Products	79
Chapter 4 The Key Distribution Problem and Public-Key Cryptography	81
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance	81 83
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme	81 83 84
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party	81 83 84 85
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme	81 83 84 85 86
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope	81 83 84 85 86 88
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues	81 83 84 85 86 88 91
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm	81 83 84 85 86 88 91 92
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography	81 83 84 85 86 88 91 92 93
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works	81 83 84 85 86 88 91 92 93 94
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm	81 83 84 85 86 88 91 92 93 94 98
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm The DH Algorithm	81 83 84 85 86 88 91 92 93 94 98 105
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm The DH Algorithm The ECDH Algorithm	81 83 84 85 86 88 91 92 93 94 98 105 111
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm The DH Algorithm The ECDH Algorithm	81 83 84 85 86 88 91 92 93 94 98 105 111 117
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm The DH Algorithm The ECDH Algorithm Comparing the Algorithms Security	81 83 84 85 86 88 91 92 93 94 98 105 111 117 117
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm The DH Algorithm The ECDH Algorithm Comparing the Algorithms Security Key Sizes	81 83 84 85 86 88 91 92 93 94 98 105 111 117 117 117
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm The DH Algorithm The ECDH Algorithm Comparing the Algorithms Security Key Sizes Performance	81 83 84 85 86 88 91 92 93 94 98 105 111 117 117 117 119 120
Chapter 4 The Key Distribution Problem and Public-Key Cryptography Sharing Keys in Advance Problems With This Scheme Using a Trusted Third Party Problems With This Scheme Public-Key Cryptography and the Digital Envelope Security Issues Breaking a Public-Key Algorithm Some History of Public-Key Cryptography How Public-Key Cryptography Works The RSA Algorithm The DH Algorithm The ECDH Algorithms Security Key Sizes Performance Transmission Size	81 83 84 85 86 88 91 92 93 94 98 105 111 117 117 117 117 119 120 122

	Contents	VII
Protecting Private Keys		122
Using the Digital Envelope for Key Recovery		122
Key Recovery via a Trusted Third Party		120
Key Recovery via a fracted finite ranty		124
Key Recovery via Threshold Schemer		120
How a Threshold Scheme Works		127
Summany		130
Real-World Example		132
Real-Woha Example		133
Chapter 5 The Digital Signature		137
The Uniqueness of a Digital Signature		138
Message Digests		141
Collisions		145
The Three Important Digest Algorithms		148
A Representative of Larger Data		149
Data Integrity		153
Back to Digital Signatures		154
Trying to Cheat		156
Implementing Authentication, Data Integrity, and Nonre	epudiation	159
Understanding the Algorithms		159
RSA		160
DSA		161
ECDSA		163
Comparing the Algorithms		163
Security		163
Performance		164
Transmission Size		165
Interoperability		165
Protecting Private Keys		166
Introduction to Certificates		166
Key Recovery		169
Summary		169
Real-World Example		170
Chapter 6 Public-Key Infrastructures and the X.509) Standard	171
Public-Key Certificates		172
Unique Identifiers		174
Standard Version 3 Certificate Extensions		175
Entity Names		177

	And a second
ASN.1 Notation and Encoding	
The Components of a PKI	179
Certification Authority	179
Registration Authority	180
Certificate Directory	180
Kev Recovery Server	181
Management Protocols	182
Operational Protocols	182
Registering and Issuing Certificator	184
Revoking a Certificate	184
Certificate Revocation Lists	185
Suspending a Certificate	186
Authority Revocation Lists	190
Trust Models	190
Certificate Hierarchies	191
Cross-Certification	192
X.509 Certificate Chain	193
The Push Model Versus the Pull Model	194
Managing Key Pairs	195
Generating Key Pairs	196
Protecting Private Keys	197
Managing Multiple Key Pairs	197
Updating Key Pairs	198
Keeping a History of Key Pairs	199
Deploving a PKI	200
The Future of PKI	201
Roaming Certificates	201
Attribute Certificates	201
Certificate Policies and Certification Practice Statements	203
Summary	204
Real-World Examples	206
Keon Certificate Server	206
Keon Web PassPort	207
	207
Chapter 7 Network and Transport Security Protocols	209
Internet Protocol Security	200
IP Security Architecture	207
IPSec Services	210
The Authentication Header Protocol	211
Integrity Check Value Calculation	212
	theme I theme

Transport and Tunnel Modes213The Encapsulating Security Payload Protocol215Encryption Algorithms216ESP in Transport and Tunnel Modes217Security Associations218Combining Security Associations219Security Databases222Security Databases222Security Policy Database222Security Nasociation Database222Security Policy Database222Security Policy Database222Security Policy Database222Security Policy Database222Security Policy Database222Security Connection States226The History of SSL227Session and Connection States228The Change Cipher Spec Protocol231The Alert Protocol233The Change Cipher Spec Protocol233The Server Key Exchange Message236The Server Key Exchange Message236The Server Key Exchange Message237The Certificate Message238The Certificate Message239The Client Key Exchange Message238The Certificate Message239The Cient Key Exchange Message230Cryptographic Connection239Encryption and Authentication Algorithms240Summary241Real-World Examples243Summary241Chapter 8 Application-Layer Security Protocols243S/MIMECyptographic Algorithms244 <td< th=""><th></th><th>Contents</th><th>IX</th></td<>		Contents	IX
The Encapsulating Security Payload Protocol213Encryption Algorithms216Encryption Algorithms217Security Associations218Combining Security Associations219Security Databases220Security Databases222Security Policy Database222Security Association Database222Security Association Database222Security Sociation Database222Security Sociation Database222Secure Sockets Layer227The History of SSL227Session and Connection States228The Record Layer Protocol230The Record Layer Protocol231The Alert Protocol232The Handshake Protocol233The Client Hello Message236The Server Hello Message236The Server Hello Message236The Server Hello Message236The Server Hello Done Message237The Server Hello Done Message238The Client Key Exchange Message238 </td <td>Transport and Tunnel Modes</td> <td></td> <td>210</td>	Transport and Tunnel Modes		210
Encryption Algorithms 1000000000000000000000000000000000000	The Encapsulating Security Payload Protocol		213
ESP in Transport and Tunnel Modes 217 Security Associations 219 Security Associations 219 Security Databases 222 Security Dolicy Database 222 Security Association Database 222 The History of SL 227 The History of SL 227 Session and Connection States 228 The Record Layer Protocol 230 The Change Cipher Spec Protocol 231 The Alert Protocol 232 The Hello Message 234 The Server Hello Message 235 The Server Hello Message 236 The Server Hello Message 237 The Server Hello Message 237 The Cient Key Exchange Message 237 The Cient Certificate Message 237 The Cient Certificate Message 237 The Cient Certificate Message 237 The Cient Certificate Message 237 The Server Hello Done Message 237 The Cient Certificate Message 237 The Cient Certificate Message 238 The Cient Certificate Message 239 Ending a Session and Connection 239 Resuming Sessions 240 Cryptographic Computations 240 Encryption and Authentication Algorithms 240 Summary 241 Real-World Examples 242 Chapter 8 Application-Layer Security Protocols 243 S/MIME Functionality 244 S/MIME Functionality 244 S/MIME Functionality 244	Encryption Algorithms		215
Security Associations217Security Associations218Combining Security Associations219Security Databases220Security Policy Database222Security Association Database222Security Association Database222Key Management223Internet Key Exchange224Secure Sockets Layer227The History of SSL227Session and Connection States228The Record Layer Protocol230The Alert Protocol231The Alert Protocol232The Server Hello Message234The Server Hello Message236The Server Key Exchange Message236The Server Key Exchange Message237The Client Certificate Message237The Client Certificate Message238The Server Hello Done Message238The Certificate Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243Overview243Overview243Overview243Overview243Overview243Overview243Overview243Overview243Overview244S/MIME Functionality245	ESP in Transport and Tuppel Modes		216
Combining Security Associations218Combining Security Associations219Security Databases222Security Policy Database222Security Association Database222Key Management223Internet Key Exchange224Secure Sockets Layer227The History of SSL227Session and Connection States228The Record Layer Protocol230The Aler Protocol231The Aler Protocol232The Aler Protocol233The Change Cipher Spec Protocol234The Server Hello Message235The Server Hello Message236The Server Hello Done Message237The Client Key Exchange Message237The Client Key Exchange Message238The Certificate Message238The Certificate Verify Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243Overview243Overview243Overview243Overview243Overview243Overview243S/MIME243Overview243S/MIME243Overview244S/MIME243Overview244S/MIME Functionality245	Security Associations		217
Security Databases 222 Security Databases 222 Security Association Database 222 Key Management 223 Internet Key Exchange 224 Secure Sockets Layer 227 The History of SSL 227 Session and Connection States 228 The Record Layer Protocol 231 The Change Cipher Spec Protocol 231 The Alert Protocol 232 The Handshake Protocol 233 The Client Hello Message 234 The Server Hello Message 235 The Server Hello Message 236 The Server Hello Done Message 237 The Server Hello Done Message 237 The Critificate Request Message 237 The Critificate Ressage 237 The Client Certificate Message 238 The Server Hello Done Message 239 The Critificate Request Message 239 The Critificate Message 239 The Client Certificate Message 239 The Client Certificate Message 239 The Client Message 239 The Client Key Exchange Message 239 The Client Certificate Message 239 The Client Key Exchange Message 239 Cryptographic Computations 240 Encryption and Authentication Algorithms 240 Encryption and Authentication Algorithms 240 Summary 241 Real-World Examples 243 Overview 243 Overview 243 S/MIME Functionality 245 Cryptographic Algorithms 245	Combining Security Associations		218
Security Policy Database222Security Policy Database222Security Association Database223Internet Key Exchange224Secure Sockets Layer227The History of SL227Session and Connection States230The Record Layer Protocol231The Alert Protocol232The Alert Protocol233The Client Hello Message234The Server Key Exchange Message236The Server Key Exchange Message237The Client Certificate Message237The Client Key Exchange Message237The Client Key Exchange Message238The Certificate Nessage238The Certificate Nessage238The Client Certificate Message238The Certificate Nessage239Ending a Session and Connection239Cryptographic Computations240Summary241Real-World Examples243Overview243S/MIME243Overview243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Security Databases		219
Security Association Database222Security Association Database223Internet Key Exchange223Internet Key Exchange227The History of SSL227Session and Connection States228The Record Layer Protocol230The Change Cipher Spec Protocol231The Alert Protocol232The Handshake Protocol233The Client Hello Message234The Server Hello Message236The Server Key Exchange Message236The Client Key Exchange Message237The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243S/MIME0verviewS/MIME Functionality243Cryptographic Algorithms243S/MIME Functionality245Cryptographic Algorithms245	Security Policy Database		220
Key Management222Internet Key Exchange223Internet Key Exchange227The History of SSL227Session and Connection States228The Record Layer Protocol230The Change Cipher Spec Protocol231The Alert Protocol232The Handshake Protocol232The Client Hello Message234The Server Hello Message236The Server Key Exchange Message236The Certificate Request Message237The Client Key Exchange Message237The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message237The Server Hello Done Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243S/MIME0verviewS/MIME Functionality243Cryptographic Algorithms243S/MIME Functionality245Cryptographic Algorithms245	Security Association Database		222
Internet Key Exchange223Secure Sockets Layer227The History of SSL227Session and Connection States228The Record Layer Protocol230The Change Cipher Spec Protocol231The Alert Protocol232The Alert Protocol233The Client Hello Message234The Server Hello Message236The Server Key Exchange Message236The Client Certificate Message237The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview243S/MIME243Chapter 8Application-Layer Security Protocols243S/MIME Functionality245Cryptographic Algorithms245	Kev Management		222
Secure Sockets Layer224Secure Sockets Layer227The History of SSL228Session and Connection States228The Record Layer Protocol230The Change Cipher Spec Protocol231The Alert Protocol232The Handshake Protocol233The Client Hello Message234The Server Hello Message236The Server Hello Message236The Server Key Exchange Message236The Certificate Request Message237The Client Key Exchange Message237The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview244S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Internet Key Exchange		223
The History of SSL227Session and Connection States230The Record Layer Protocol231The Change Cipher Spec Protocol231The Alert Protocol232The Handshake Protocol233The Client Hello Message234The Server Hello Message236The Server Key Exchange Message236The Certificate Request Message237The Client Hello Done Message237The Client Key Exchange Message237The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message238The Client Certificate Message238The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Ending a Session and Connection239Ending a Session and Connection240Cryptographic Computations240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Chapter 8Application-Layer Security Protocols243S/MIME Functionality245Cryptographic Algorithms245	Secure Sockets Laver		224
Session and Connection States227The Record Layer Protocol230The Change Cipher Spec Protocol231The Alert Protocol232The Alert Protocol233The Client Hello Message234The Server Hello Message235The Server Certificate Message236The Server Key Exchange Message237The Server Hello Done Message237The Client Hello Done Message237The Client Key Exchange Message237The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243Overview244S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	The History of SSL		221
The Record Layer Protocol230The Change Cipher Spec Protocol231The Alert Protocol232The Alert Protocol233The Alert Protocol233The Client Hello Message234The Server Hello Message235The Server Certificate Message236The Server Key Exchange Message237The Server Hello Done Message237The Client Hello Done Message237The Client Certificate Message237The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243Overview244S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Session and Connection States		221
The Change Cipher Spec Protocol231The Alert Protocol232The Alert Protocol233The Client Hello Message234The Server Hello Message235The Server Certificate Message236The Server Key Exchange Message237The Client Certificate Request Message237The Client Certificate Message238The Client Certificate Message237The Client Certificate Message238The Client Certificate Message238The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Encling a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243S/MIME243Overview244S/MIME243Chapter 8Application-Layer Security Protocols243Cryptographic Algorithms244S/MIME Functionality245Cryptographic Algorithms244	The Record Laver Protocol		228
The Alert Protocol231The Alert Protocol232The Handshake Protocol233The Client Hello Message234The Server Hello Message235The Server Key Exchange Message236The Server Key Exchange Message237The Certificate Request Message237The Client Certificate Message237The Client Certificate Message237The Client Certificate Message238The Client Key Exchange Message238The Client Key Exchange Message238The Crificate Verify Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245Cryptographic Algorithms245	The Change Cipher Spec Protocol		230
The Handshake Protocol232The Client Hello Message234The Server Hello Message235The Server Certificate Message236The Server Key Exchange Message237The Server Hello Done Message237The Client Certificate Message237The Client Certificate Message237The Client Certificate Message237The Client Certificate Message238The Client Certificate Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245Cryptographic Algorithms245	The Alert Protocol		231
The Client Hello Message233The Server Hello Message235The Server Certificate Message236The Server Key Exchange Message236The Certificate Request Message237The Client Certificate Message237The Client Certificate Message237The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245Cryptographic Algorithms245	The Handshake Protocol		232
The Server Hello Message234The Server Certificate Message236The Server Key Exchange Message236The Server Key Exchange Message237The Certificate Request Message237The Client Certificate Message237The Client Certificate Message238The Client Key Exchange Message238The Client Key Exchange Message238The Client Key Exchange Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245Cryptographic Algorithms245	The Client Hello Message		233
The Server Certificate Message236The Server Key Exchange Message236The Server Key Exchange Message237The Certificate Request Message237The Server Hello Done Message237The Client Certificate Message238The Client Key Exchange Message238The Client Key Exchange Message238The Certificate Verify Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245S/MIME Functionality245Cryptographic Algorithms245	The Server Hello Message		234
The Server Key Exchange Message236The Certificate Request Message237The Server Hello Done Message237The Client Certificate Message238The Client Key Exchange Message238The Certificate Verify Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245Cryptographic Algorithms245	The Server Certificate Message		200
The Certificate Request Message237The Server Hello Done Message237The Client Certificate Message237The Client Certificate Message238The Client Key Exchange Message238The Certificate Verify Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245Cryptographic Algorithms245	The Server Key Exchange Message		200
The Server Hello Done Message237The Client Certificate Message238The Client Key Exchange Message238The Certificate Verify Message238The Certificate Verify Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	The Certificate Request Message		230
The Client Certificate Message237The Client Key Exchange Message238The Client Key Exchange Message238The Certificate Verify Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8Application-Layer Security Protocols243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	The Server Hello Done Message		237
The Client Key Exchange Message238The Certificate Verify Message238The Certificate Verify Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8Application-Layer Security Protocols243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	The Client Certificate Message		227
The Certificate Verify Message238The Finished Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8 Application-Layer Security ProtocolsS/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	The Client Key Exchange Message		207
The Finished Message239Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8Application-Layer Security Protocols243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	The Certificate Verify Message		200
Ending a Session and Connection239Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8 Application-Layer Security ProtocolsS/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	The Finished Message		200
Resuming Sessions240Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8 Application-Layer Security ProtocolsS/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Ending a Session and Connection		237
Cryptographic Computations240Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8 Application-Layer Security ProtocolsS/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Resuming Sessions		207
Encryption and Authentication Algorithms240Summary241Real-World Examples242Chapter 8Application-Layer Security Protocols243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Cryptographic Computations		240
Summary Real-World Examples241Chapter 8Application-Layer Security Protocols243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Encryption and Authentication Algorithms		240
Real-World Examples242Chapter 8Application-Layer Security Protocols243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Summary		241
Chapter 8Application-Layer Security Protocols243S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Real-World Examples		242
S/MIME243Overview244S/MIME Functionality245Cryptographic Algorithms245	Chapter 8 Application-Layer Security Protocols		243
Overview244S/MIME Functionality245Cryptographic Algorithms245	S/MIME		743
S/MIME Functionality 245 Cryptographic Algorithms 245	Overview		243
Cryptographic Algorithms 245	S/MIME Functionality		244
	Cryptographic Algorithms		245

S/MIME Messages	247
Enhanced Security Services	252
Interoperability	253
Secure Electronic Transaction (SET)	253
Business Requirements	254
SET Features	255
SET Participants	256
Dual Signatures	257
SET Certificates	258
Payment Processing	260
Summary	264
Real-World Examples	265
Chapter 9 Hardware Solutions: Overcoming Software Limitations	267
Cryptographic Accelerators	267
Authentication Tokens	269
Token Form Factors	270
Noncontact Tokens	270
Contact Tokens	275
Smart Cards	275
Smart Card Standards	276
Types of Smart Cards	276
Readers and Terminals	278
JavaCards	279
History and Standards	279
JavaCard Operations	280
Other Java Tokens	281
Biometrics	282
Biometric Systems Overview	282
Recognition Methods	285
Biometric Accuracy	288
Combining Authentication Methods	289
Summary	291
Vendors	291
Chapter 10 Digital Signatures: Beyond Security	293
Legislative Approaches	295
Legal Guidelines from the American Bar Association	295
Legal Concepts Related to Digital Signatures	296

	Contents	XI
Nonrepudiation		296
Authentication		270
Written Versus Digital Signatures		270
Requirements for the Use of Digital Signatures		2.77
Public Key Infrastructures		277
Control of Key Revocation		200
Time-Stamping		300
Current and Pending Legislation		300
The F-SIGN Act		302
Dealing with Legal Uncertainties		303
Summary		306
Real-World Examples		307
Real-world Examples		307
Chapter 11 Doing It Wrong: The Break-Ins		309
Measuring Losses		309
Types of Security Threats		310
Unauthorized Disclosure of Data		311
Unauthorized Modification of Data		311
Unauthorized Access		312
Disclosure of Network Traffic		313
Spoofing of Network Traffic		314
Identifying Intruders		314
Insiders		315
Hackers		215
Terrorists		212
Foreign Intelligence Services		212
Hactivists		214
Intruder Knowledge		210
Case Studies		317
Data in Transit		217
Data at Rest		210
Authentication		318
Implementation		319
Information Security: Law Enforcement		320
Summary		321
Sommery		322
Chapter 12 Doing It Right: Following Standards		323
Security Services and Mechanisms		324
Authentication		324

Contents

Confidentiality	326
Integrity	326
Nonrepudiation	327
Standards, Guidelines, and Regulations	327
The Internet Engineering Task Force	327
ANSI X9	328
National Institute of Standards and Technology	328
Common Criteria	330
The Health Insurance Portability Act	330
Developer Assistance	331
Insurance	332
Security Research	332
Case Studies	333
Implementation	333
Authentication	334
Data at Rest	335
Data in Transit	336
Summary	336
Appendix A Bits, Bytes, Hex, and ASCII	339
Appendix B A Layman's Guide to a Subset of ASN.1, BER, and DER	347
Appendix C Further Technical Details	387
Index	407

XII



-ROM at Back Cove The software and information on this CD-ROM (collectively referred to as the "Product") are the property of RSA Security Inc. ("RSA Security") and are protected by both United States copyright law and international copyright treaty provision. You must treat this Product just like a book, except that you may copy it into a computer to be used and you may make archival copies of the Products for the sole purpose of backing up our software and protecting your investment from loss.

By saying "just like a book," RSA Security means, for example, that the Product may be used by any number of people and may be freely moved from one computer location to another, so long as there is no possibility of the Product (or any part of the Product) being used at one location or on one computer while it is being used at another. Just as a book cannot be read by two different people in two different places at the same time, neither can the Product be used by two different people in two different places at the same time (unless, of course, RSA Security's rights are being violated).

RSA Security reserves the right to alter or modify the contents of the Product at any time.

This agreement is effective until terminated. The Agreement will terminate automatically without notice if you fail to comply with any provisions of this Agreement. In the event of termination by reason of your breach, you will destroy or erase all copies of the Product installed on any computer system or made for backup purposes and shall expunge the Product from your data storage facilities.

LIMITED WARRANTY

RSA Security warrants the CD-ROM(s) enclosed herein to be free of defects in materials and workmanship for a period of sixty days from the purchase date. If RSA Security receives written notification within the warranty period of defects in materials or workmanship, and such notification is determined by RSA Security to be correct, RSA Security will replace the defective diskette(s). Send request to:

RSA Press RSA Security Inc. 2955 Campus Drive Suite 400 San Mateo, CA 94403

The entire and exclusive liability and remedy for breach of this Limited Warranty shall be limited to replacement of defective CD-ROM(s) and shall not include or extend any claim for or right to cover any other damages, including but not limited to, loss of profit, data, or use of the software, or special, incidental, or consequential damages or other similar claims, even if RSA Security or The McGraw-Hill Companies, Inc. ("McGraw-Hill") has been specifically advised as to the possibility of such damages. In no event will RSA Security's or McGraw-Hill's liability for any damages to you or any other person ever exceed the lower of suggested list price or actual price paid for the license to use the Product, regardless of any form of the claim.

RSA SECURITY INC. AND THE McGRAW-HILL COMPANIES, INC. SPECIFICALLY DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Specifically, neither RSA Security nor McGraw-Hill makes any representation or warranty that the Product is fit for any particular purpose and any implied warranty of merchantability is limited to the sixty day duration of the Limited Warranty covering the physical CD-ROM(s) only (and not the software or information) and is otherwise expressly and specifically disclaimed.

This Limited Warranty gives you specific legal rights; you may have others which may vary from state to state. Some states do not allow the exclusion of incidental or consequential damages, or the limitation on how long an implied warranty lasts, so some of the above may not apply to you.

This Agreement constitutes the entire agreement between the parties relating to use of the Product. The terms of any purchase order shall have no effect on the terms of this Agreement. Failure of RSA Security to insist at any time on strict compliance with this Agreement shall not constitute a waiver of any rights under this Agreement. This Agreement shall be construed and governed in accordance with the laws of Massachusetts, irrespective of its choice of law principles. If any provision of this Agreement is held to be contrary to law, that provision will be enforced to the maximum extent permissible and the remaining provisions will remain in force and effect.



506



Learn how cryptography works from the leading authority in e-security

Cryptography is one of the smartest ways to protect the information on your network and reduce the risk of security breaches and attacks from hackers. And because implementing cryptography is a complex process, you need the practical advice and proven techniques contained inside this official guide. Written by insiders at RSA Security, this expert resource explains the differences between symmetric-key and public-key cryptography, how PKI and X.509 affect security, how the RSA algorithm works within protocols, and

much more. You'll also read actual case studies detailing different types of security vulnerabilities and what types of cryptography applications

USBORNE

REQUIRED READING for the Information Age

A Division of The McGraw-Hill Companie

\$59.99 USA

would prevent attacks.

ONLY AVAILABLE FROM RSA SECURITY RSA Laboratories' complete FAQ 4.1 Public-Key Cryptography Standards Crypto Bytes Technical Newsletters

£43.99 UK

rtest

- Distinguish different types of symmetric-key encryption algorithms and know where each is best used
- Find out how password-based encryption works
- Communicate safely over unsecure channels using public-key technology
- Use public-key technology for authentication and non-repudiation
- Recognize how corporations use cryptography to improve security through real-world case studies

Get details on current PKI standards and technology including vendor information

RSA PR

- Understand X.509 certificates and directory structures
- Get an operational overview of widely-used protocols including IPSec, SSL, and SET
- View cryptography from different perspectives—corporations, developers, and users
- Effectively use digital signatures and hardware solutions—smart cards, tokens, key storage devices, and more

Improve security and protect your company's information with the most authoritative guide cryptography available.

ABOUT THE AUTHORS:

STEVE BURNETT has degrees in math from Grinnell College in Iowa and The Claremo School in California. He has spent most of his career converting math into computer p at Intergraph Corporation and now with RSA Security. A frequent speaker at industry and college campuses, Steve is the lead engineer for RSA's BSAFE Crypto-C and Cryp products, which are general purpose cryptography software development kits in C'an

STEPHEN PAINE has worked in the security field throughout most of his career for United States Marine Corps and for SUN Microsystems. He is currently a systems en Security, where he explains security concepts to corporations and developers work provides training to customers and RSA employees.



200



APPENDIX D



Search WorldCat

Search

Ac

	Results			Cite/Export	Print	E-mail	Share	<u>r crinc</u>
Add to list	Add tags	Write a revi	iew Rate this item: 1	2 3 4 5				
		RSA secu	rity's official g	uide to crypto	graphy	Get a C	ору	
		Author:	Steve Burnett; Stephe	n Paine		Find a c	copy in the lib	orary
Security's Official G	nide to	Publisher:	New York : Osborne/M	cGraw-Hill, cop. 2001				
CRYPTOGRAPHY		Edition/Format:	Frint book : English	View all editions and f	ormats	AbeBoo	<u>oks</u>	\$1.72
		Summary:	Helps in implementing cryptography, the most secure form of data encryption. This work, with		Amazo	<u>n</u>	\$71.2	
sa mana (prod Sinne Bern	en & Disades fains e		case studies, is written in conjunction with "RSA Security". It is a part of the "RSA Press Series".			Barnes	& Noble	\$49.9
		Rating:	(not yet rate	d) <u>0 with reviews - E</u>	Be the first.	Better	World Books	\$4.9
,		Subjects	Computer networks	Security measures.	÷	iTunes		\$39.9
			Data encryption (Com Cryptography. View all subjects	<u>puter science)</u>				
		More like this	Similar Itoms					
Enter you	ur location:	District of Co al address for be	lumbia Find librari	es				
Enter you Submit a co	ur location: omplete posta	District of Co District of Co al address for be	Iumbia Find librari est results.	es)	S	how libraries h	holding j <u>ust thi</u>	s edition
Enter you Submit a co	ur location: omplete posta	Did this item District of Co al address for be	Iumbia Find librari est results. ions (Washington, DC, USA « First < Prev	es) 1 <u>2 3 Next > Last</u> >>	S	how libraries h	olding j <u>ust thi</u>	s edition
Enter you Submit a co Displaying lib	ur location: omplete posta	District of Co District of Co al address for be	Iumbia est results. ions (Washington, DC, USA & First & Prev	es) 1 <u>2 3 Next > Last</u> » Held formats	S Distanc	how libraries h	olding j <u>ust thi</u> :	s edition
Enter you Submit a co Displaying lib Library 1.	ibrary of C Washin	District of Co al address for be f 575 for all 19 edit ongress gton, DC 2054	Iumbia Find librari est results. ions (Washington, DC, USA ≪ First ∢ Prev 0 United States) 1 <u>2</u> <u>3 Next</u> > <u>Last</u> >> Held formats Book	S Distanc 2 mile MAP I	how libraries h e S T	olding j <u>ust this</u> Library info <u>Ask a librar</u> Add to favo	s edition
Enter you Submit a co Displaying lib Library 1. L 2. A L	ibrary of C Washing Marington Pu ibrary Adn Arlington	District of Co al address for be f 575 for all 19 edit ongress gton, DC 2054 ublic Library ninistration un, VA 22201 U	Iumbia Find librari est results. ions (Washington, DC, USA « First < Prev 0 United States	es) 1 2 3 Next > Last >> Held formats Book Book	S Distanc 2 mile MAP I 4 mile MAP I	how libraries h e S T T T	Library info Ask a librar Add to favo Ask a librar Add to favo	s edition ian rites ian rites
Enter you Submit a cc Displaying lib Library 1. L 2. A L 3. L	ibrary of C Washing Arlington Pu ibrary Adn Arlingto Jniversity C JMD Librar	District of Co al address for be f 575 for all 19 edit ongress gton, DC 2054 ublic Library ninistration n, VA 22201 U of Maryland L ies Park, MD 207	Iumbia Find librari est results. ions (Washington, DC, USA	es	S Distanc 2 mile MAP I 4 mile MAP I 7 mile MAP	how libraries h e s T S T S S T	Library info Ask a librar Add to favo Library info Ask a librar Add to favo Library info Search at ti Ask a librar Add to favo	s edition ian rites his library ian rites
Enter you Submit a cc Displaying lib Library 1. L 2. A L 3. L 4. L	ibrary of C Washing Arlington Pr ibrary Adn Arlingto Jniversity C JMD Librar College Jniversity C JMUC Librar Adelphi	District of Co al address for be f 575 for all 19 edit ongress gton, DC 2054 ublic Library ninistration n, VA 22201 U of Maryland L ies Park, MD 20783 Un i, MD 20783 Un	Iumbia Find librari est results. ions (Washington, DC, USA « First < Prev 0 United States inited States ibraries 42 United States Jniversity College	es	S Distance 2 mile MAP I 4 mile MAP I 7 mile MAP 10 mi MAP	how libraries h e S T PS T es T I les IT	Library info Ask a librar Add to favo Library info Ask a librar Add to favo Library info Search at th Ask a librar Add to favo Library info Search at th Ask a librar Add to favo	s edition

https://www.worldcat.org/title/rsa-securitys-official-guide-to-cryptography/oclc/782997409?referer=br&ht=edition

4/7/2019

RSA security's official guide to cryptography (Book, 2001) [WorldCat.org]

6. Bowie Sta Thurgood Bowi	ate University I Marshall Library e, MD 20715 United States	Book	17 miles MAP IT	Library info Add to favorites		
	≪ First ≺ Pre	v 1 <u>2 3 Next > Last</u> >>				
Details						
Genre/Form:	Handboeken (vorm)					
Material Type:	Internet resource					
Document Type:	Book, Internet Resource					
All Authors /	Steve Burnett; Stephen Paine					
Contributors:	Find more information about:	Steve Burnett V Go				
ISBN:	007213139X 9780072131390 0072	131381 978007213138	3 0072131373 978007	2131376		
OCLC Number:	782997409					
Notes:	Includes index.					
Description:	xxi, 419 p. : ill. ; 24 cm + CD-ROM v	/.d.t.: RSA security's cor	mplete cryptography			
	Management. Chapter 4: The Key I Digital Signature. Chapter 6: Public- Transport Security Protocols. Chapt Solutions: Overcoming Software Lin Doing It Wrong: The Break-Ins. Cha Hex, and ASCII. Appendix B: A Lay Technical Details.	Distribution Problem and Key Infrastructures and ter 8: Application-Layer nitations. Chapter 10: D apter 12: Doing It Right: man's Guide to a Subse	I Public-Key Cryptogra I the X.509 Standard. (Security Protocols. Ch igital Signatures: Beyo Following Standards. / et of ASN.1, BER, and	phy. Chapter 5: The Chapter 7: Network and apter 9: Hardware nd Security. Chapter 11: Appendix A: Bits, Bytes, DER. Appendix C: Furth		
Other Titles:	Cryptography RSA security's complete cryptograp	hy				
Responsibility:	Steve Burnett and Stephen Paine.					
More information:	catdir.loc.gov catdir.loc.gov ca	atdir.loc.gov				
Reviews			la distributiva analo esta antica de anti			
User-contributed r	eviews					
Add a review and	share your thoughts with other readers.	Be the first.				
Tags						
Add tags for "RSA se	ecurity's official guide to cryptography".	Be the first.				
Similar Items						
		511				

RSA security's official guide to cryptography (Book, 2001) [WorldCat.org]

Computer networks -- Security measures.

Data encryption (Computer science)

Cryptography.

Cryptografie.

Computerbeveiliging.

TCP/IP.

+ Linked Data

512