Contents

1	Authentication Basics	
	Types of Authentication Approaches	
	Type I: What You Know? 3	,
	Type II: What You Have?	
	Type III: What You Are?21	
	Type IV: Where You Are?	
	User Account Types29	,
	Chapter Summary30	
	References	
2	Biometric Authentication 37	,
	Introduction38	,
	Different Biometric Modalities	
	Biometric Authentication Process42	!
	Performance Measures of Biometric Systems45	
	False Acceptance Rate (FAR)45	
	False Rejection Rate (FRR)45	
	Equal Error Rate (EER)	
	Failure to Enroll Rate (FTE)47	
	Failure to Acquire Rate (FTA)47	
	Details of Biometric Authentication Modalities47	
	Face Recognition47	,
	Fingerprint Recognition49	,
	Iris Recognition51	
	Retina Recognition52	
	Hand Geometry53	
	Voice (Speaker) Recognition55	
	Keystroke Recognition57	
	Gait-Based Recognition57	
	Brainprint61	ı
	Applications of Biometrics61	
	Banking63	ì
	Computer Access64	
	Immigration64	ŀ
	National Identity64	
	Prisons65	,
	Telecommunications65	,
	Time and Attendance65	5
	Limitations of Biometric Systems	j
	New Biometric Challenges	
	Attacks on Biometric-Based Authentication Systems	
	Mitigating Different Attacks on Biometric Systems	
	Liveness Detection Mechanisms71	

	Steganographic and Watermarking Techniques	71
	Challenge-Response Systems	72
	Multimodal Biometric Systems	73
	Soft Biometrics	75
	Cancelable Biometrics	76
	Comparative Evaluation	77
	Chapter Summary	79
	References	
3	Negative Authentication Systems	85
	Introduction	86
	Concept of Negative Authentication	87
	Types of NAS	90
	Implementation of Negative Authentication System (NAS)	9 5
	Chapter Summary	. 143
	References	. 144
4	Pseudo-Passwords and Non-textual Approaches	. 147
	Evolution of Hash Functions	. 148
	Honeyword Approach	. 149
	Honeychecker	. 150
	NLEs from the <i>n</i> -Gram Model Concept	. 156
	NLEs from the PCFG Model Concept	. 157
	Encoding or Decoding of the Sub-grammar (SG)	. 158
	Evaluating the Encoders	
	Evaluating Single Passwords	. 159
	No Crack Password Vaults	. 160
	Bloom Filter	. 161
	Constructing Bloom Filters	
	Comparison of Complementary Approaches: NAS (G-NAS, GM-NAS),	
	Honeywords, and Bloom Filter	. 164
	Non-textual Passwords	. 165
	Recognition-Based Techniques	. 167
	Recall-Based Techniques	. 171
	Security Aspects and Possible Attacks on Graphical Passwords	. 175
	Chapter Summary	. 179
	References	. 180
5	Multi-Factor Authentication	. 185
	Introduction	. 186
	Issues of Single-Factor Authentication (SFA)	. 188
	Two-Factor-Based Authentication	. 188
	Different Authentication Factors Considered in MFA	. 190
	Necessity to Move Toward MFA	
	Different Characteristics of a Good MFA	
	Easy to Use	
	Scalable	
	Resilient	
	Reliable	

	Single Sign-On	. 193
	Fast Identity Online (FIDO)	196
	Universal Authentication Framework (UAF)	198
	Universal Second Factor (U2F)	198
	How FIDO Works	198
	MFA Authentication Products	
	CA Strong Authentication	201
	Okta Verify	
	Vasco IDENTIKEY Authentication Server 3.8	
	Dell Defender	
	Symantec Validation and ID Protection Service (VIP)	
	RSA SECURID	
	SafeNet Authentication Service	
	SecureAuth IdP 8.0	
	Microsoft Azure	
	Swivel Secure	
	DUO Security	
	Comparison of Various MFA Products	
	Chapter Summary	
	References	
6	Continuous Authentication	
•	Introduction	
	Continuous/Active Authentication	
	Characteristics of a Good Continuous Authentication System	
	Steps to Design Continuous Authentication System	
	Attribute Selection for Continuous Authentication System	
	Unimodal Continuous Authentication	
	Face Recognition	
	Partial Face Recognition	
	Web Browsing Behavior	
	Dynamic Context Fingerprints	
	Keystroke Dynamics	
	Cognitive Fingerprint	
	Screen Fingerprints	
	Stylistic Fingerprint	
	Hand Movement, Orientation, and Grasp (HMOG)	
	Multi-modal Continuous Authentication	233
		252
	and System Footprint	
	Active Authentication for Mobile Devices	
	Stylometry, Application Usage, Web Browsing, and GPS Location	
	Multi-sensor Text-Based Biometric	
	Gestures, Keystroke, Touch, and Body Movements	
	Keystroke, Mouse Movement, Stylometry, Web Browsing Behavior	
	Smartphone-Based Multi-sensor Authentication	
	Continuous Authentication for Internet of Things (IoT)	. 266

	Self-authenticable Approaches for Wearable Devices	267
	The National Strategy for Trusted Identities in Cyberspace (NSTIC)	269
	Chapter Summary	
	References	275
7	Adaptive Multi-factor Authentication	281
	Introduction	282
	Adaptive-MFA (A-MFA) Framework	283
	Authentication Factor	
	Considered Surrounding Conditions for MFA	285
	Trustworthy Framework for Authentication Factors	288
	First Approach	
	Second Approach	
	Adaptive Selection Approach for MFA	306
	Implementation of Adaptive-MFA System	
	Surrounding Conditions (Light and Noise)	
	Database to Store Authentication Factors	
	Configuration of A-MFA System	314
	Client Application	
	Experimental Results of the A-MFA System	336
	Creation of Synthetic Dataset	
	System Evaluation Criteria	338
	Experimental Results	
	Comparison of Adaptive Selection Approach with Random	
	and Only Biometric-Based Approaches	342
	Advantage over Other Existing MFA Approaches	
	Future Trends	
	Chapter Summary	350
	References	
	Service Part	
	Index	358