

Index

- account, 189
- account-based issuing protocol, 189
- account-less issuing protocol, 190
- ACES, 4, 13, 18, 25
- active attack, 46
- adaptively chosen formula attack, 96
- adaptively chosen message attack, 79
- addition chain, 51, 56
- adversary, 46
- algorithm, 42
 - adversary, 46
 - attacker, 45
 - active, 46
 - infinitely powerful, 46, 92, 215–216
 - passive, 46
 - black-box, 45, 48
 - honest, 45
 - interactive, 44
 - simulator, 68, 87, 100, 205
- anonymity, 11, 31, 34, 190
- anonymous
 - account, 190, 209, 216
 - attribute recertification, 34, 145, 209
 - certificate issuing
 - drawbacks of, 190, 209
 - channel, 265–266
 - extortioner, 17, 230, 245, 251
 - issuing of smartcard, 252–253
 - refreshing of attributes, 190
 - updating of attributes, 34, 191, 212, 216
- anonymous registration
 - drawbacks of, 26
- atomic formula, 119
- attack
 - active, 46
 - adversary, 46
 - fake-terminal, 224
 - model, 45–48
 - on digital signatures, 78–79
 - adaptively chosen message attack, 79
 - existential forgery, 79
 - forgery from scratch, 79
 - key-only attack, 79
 - total break, 79
 - passive, 46
- attacker, 45
 - active, 46
 - infinitely powerful, 46, 92, 215–216
 - passive, 46
- attribute, 9
- attribute certificate, 9–13
 - privacy dangers of, 20–25
 - recertification of, 34, 145, 209
 - refreshing of, 190
 - SPKI, 12, 22, 27
 - SPKI/SDSI 2.0, 15

- Tokeneer, 12, 19
 - updating of, 34, 191, 212, 216
- batch-verification, 82, 85, 126, 128, 201
- blind signatures, 27, 78, 81, 83, 208
 - drawbacks of, 28, 227
 - restrictive, 131–179
 - security in random oracle model, 81
 - technique of Okamoto and Ohta, 81, 83, 86
- blinding-invariant, 33, 132
- C-SET, 18
- central database paradigm, 6
 - drawbacks of, 6–9
- certificate
 - attribute, *see* attribute certificate
 - digital, *see* digital certificate
 - identity, *see* identity certificate
 - paper-based, 1, 208, 253
- Certificate Authority, 3
- certificate issuing protocol, 32
 - restrictive blind, 131–179
- certificate showing protocol, 33
 - with selective disclosure, 27, 31, 35, 91–130
- certified key pair, 86
 - extortion of, 17, 145, 230, 245, 251
- certified public key, 86
- challenge
 - of the verifier, 71
 - self-chosen, 120, 128
 - semantics, 247
- Chaum-Pedersen signatures, 175
- chipcard, 6
- collision-intractable function, 58–59
- commitment
 - function, 50, 58, 61, 65, 76, 91
 - opening a, 50, 61, 65
- common coin flips, 230, 244, 245
 - drawbacks of preventing, 230
- completeness, 67
- composition of protocols, 46, 69
- computation error channel, 221, 243
- computing device
 - software-only, 15, 225
 - tamper-resistant
 - iButton, 18
 - smartcard, *see* smartcard
- correction factor, 202–204
- correlation-intractable function, 84
- credential, 11, 28, 228
- credit report accuracy, 8
- CRL, 13, 17, 23, 209, 210, 250, 253
 - drawbacks of, 14
- cryptographic action, 88
- cryptographic coprocessor, 248
 - performance of, 248
- cyberspace, 2
 - systematical monitoring of, 21
- data leakage
 - computation error channel, 221, 243
 - Faraday Cage, 192, 226
 - halting channel, 221, 244
 - physical broadcast channel, 221
 - piggyback channel, 221, 227
 - subliminal channel, 37, 221, 227
 - inflow, 222, 239–240
 - outflow, 222, 240–242
 - timing channel, 221, 244
 - van Eck effect, 24, 221, 226
- delta-CRL, 13
- designated-verifier proof, 191
- Diffie-Hellman problem, 164
- digital bearer certificate, 208, 253
- digital certificate, 3, 86–89
 - attribute, 9–13
 - bearer, 208, 253
 - discarding, 2, 17, 26, 213
 - extortion, 17, 230, 245, 251

- identity, 3–5
- issuing protocol, 32
 - account-based, 189
 - account-less, 190
 - restrictive blind, 131–179
- lending, 211–212
 - remote, 251–252
- limited-show, 13, 35, 197–208
 - overruling of, 208
- long-lived, 14, 190
- one-show, 197–207
 - dynamic, 201–207
 - static, 197–201
- personal, 16, 26, 208, 211
- privacy dangers of, 20–25
- pseudonymous, 25, 26
- public-key, 86
- returning a, 250–251
- revocation of, 13–15, 17, 20, 23
- secret-key, 34, 87–89
- short-lived, 13, 15, 19, 38, 190
- showing protocol, 33
 - with selective disclosure, 27, 31, 35, 91–130
- unlimited-show, 35, 208, 234
- validation, 13, 190
- digital pseudonym, 35, 189, 209
- digital signature, 77–86
 - blind, *see* blind signatures
 - Chaum-Pedersen, 175
 - DSA, 171, 236, 249
 - elliptic curve DSA, 175
 - Guillou-Quisquater, 85
 - of the Fiat-Shamir type
 - in random oracle model, 80
 - restrictive blind, 131–179
 - RSA, 87
 - Schnorr, 83
 - signed proof, 80
 - unforgeability of, 77
- discarding certificates, 2, 17, 26, 213
- distance bounding, 252, 255
- DL function, 51–56
- DL-representation, 59
 - proving knowledge of, 71–75
 - trivial, 59
- DLREP function, 59–62, 90
 - compared to RSAREP function, 65–66
 - proof of knowledge for, 71–75
- drawbacks
 - of anonymous certificate issuing, 190, 209
 - of anonymous registration, 26
 - of blind signatures, 28, 227
 - of central database paradigm, 6–9
 - of certificate revocation, 14
 - of computational privacy, 39
 - of designated-verifier proofs, 192
 - of identity certificates, 10, 20–25, 31
 - of key escrow, 262–266
 - of preventing common coin flips, 230
 - of privacy legislation, 257–259
 - of self-regulation, 259–262
 - of smartcard-only setting, 219–224
- DSA, 171, 236, 249
 - elliptic curve variant, 175
- DSig, 12
- ECDSA, 175
- Echelon, 21
- Enfopol, 21
- European Privacy Directive, 25n
- exact security, 48
- extortion attack, 17, 230, 245, 251
 - protection against, 145, 265
- factoring problem, 55, 57
- fake-terminal attack, 224
- Faraday Cage, 192, 226

- Fiat-Shamir type proof of knowledge, 79
- forgery from scratch, 79
- formula
 - atomic, 119
 - status of, 96
- Fortezza, 4, 18
- FPKI, 4, 24, 270
- function, 42
 - collision-intractable, 58–59
 - commitment, 50, 58, 61, 65, 76, 91
 - correlation-intractable, 84
 - DL, 51
 - DLREP, 59–62
 - idealized, 49
 - infinite collection, 49
 - index set for, 49
 - instance generator for, 49
 - invulnerable, 50
 - negligible, 43
 - non-negligible, 43
 - one-way, 49–58
 - sufficiently strong, 84
 - overwhelming, 43
 - RSA, 56–58
 - RSAREP, 62–65
- generic description (of protocol), 71, 98, 113, 115, 202
- group of prime order, 51–53
 - elliptic curve construction, 53
 - subgroup construction, 51
- Guillou-Quisquater proof of knowledge, 76
- Guillou-Quisquater signatures, 85
- halting channel, 221, 244
- handheld device
 - PDA, 226
- honest algorithm, 45
- honest-verifier zero-knowledge, 68
- iButton, 18n
- ICE, 21
- idealized function, 49
- identifier, 3
- identity certificate, 3–5
 - PGP, 5, 14, 18, 26
 - privacy dangers of, 20–25
 - SDSI 1.0, 12, 22, 26
 - X.509, 3, 210
 - ACES, 4, 13, 18, 25
 - C-SET, 18
 - Fortezza, 4, 18
 - FPKI, 4, 24, 270
 - PEM, 4
 - PKIX, 4, 13
 - S/MIME, 4
 - SET, 4, 18, 27, 248
- identity fraud, 9, 10, 31
- immunization, 162–171
- index set, 49
- indistinguishable
 - computationally, 44
 - perfectly, 43
 - statistically, 43
- inflow, 222, 239–240
- infomediaries, 261
- initial witness, 71
 - master, 205
 - set, 120
- instance generator, 49
 - invulnerable, 50
 - for the DL function, 51–54
 - for the DLREP function, 60–61
 - for the RSA function, 56–57
 - for the RSAREP function, 63–65
- interactive algorithm, 44
- Internet Archive, 21
- interval proof, 129–130
- intractable problem, 43
- invulnerable instance generator, 50

- issuing protocol, 32
 - account-based, 189
 - account-less, 190
 - restrictive blind, 131–179
- key escrow, 262–266
 - electronic cash, 264
 - electronic voting, 263
 - encryption, 264
- key pair, 66
 - certified, 86
- key set-up, 66, 70
- key-only attack, 79
- knowledge extractor, 67, 95, 111
- language, 43
 - computationally indistinguishable, 44
 - perfectly indistinguishable, 43
 - statistically indistinguishable, 43
- lending of certificate, 211–212
 - remote, 251–252
- limited-show certificate, 13, 35, 197–208
 - overruling of, 208
- linkability, 26, 30, 35, 189, 190, 212, 253
- long-lived certificate, 14, 190
- long-term security, 201, 207
- low-cost smartcards, 225, 248–250
- metric of authentication, 5
- move, 44
- national ID card, 25
- negligible function, 43
- non-negligible function, 43
- non-negligible uncertainty, 73
- non-repudiation, 26, 189, 212–213
- normalized form, 63
- OCSP, 13
- OECD Policy Guidelines, 25n
- one-show certificate, 197–207
 - dynamic, 201–207
 - static, 197–201
- one-time public key, 200
- one-way function, 49–58
- online certificate validation, 13
 - drawbacks of, 14
 - OCSP, 13
- OpenCard Framework, 225
- OPS, 12, 27
 - privacy dangers of, 27
- outflow, 222, 240–242
- overwhelming function, 43
- overwhelming probability, 43
- P3P, 12, 21, 27
 - privacy dangers of, 27
- paper-based certificate, 1, 208, 253
- passive attack, 46
- PC/SC Workgroup, 225
- PDA, 226
- PEM, 4
- perfect crime, 230
- personal certificate, 16, 26, 208, 211
- PGP, 5, 14, 18, 26
- physical broadcast channel, 221
- piggyback channel, 221, 227
- PKI, 3
- PKIX, 4, 13
 - Jonah implementation of, 4
- PolicyMaker, 11
- polylogarithmic running time, 80n
- privacy
 - dangers, *see* privacy dangers
 - definition of, 20, 262
 - European Privacy Directive, 25n
 - legislation, 257–259
 - OECD Policy Guidelines, 25n
 - pragmatist, 31
 - ways to protect, 257–271
- privacy dangers
 - of central databases, 7–9

- of digital certificates, 20–25
- of key escrow, 262–266
- of OPS/P3P, 27
- of self-regulation, 259–262
- of smartcards, 24, 219–223
- privacy-enhancing technologies (benefits), 266–268
- probability
 - negligible, 43
 - non-negligible, 43
 - overwhelming, 43
- proof of knowledge, 66–71
 - completeness, 67
 - convert into digital signature, 79–81
 - designated-verifier, 191
 - Guillou-Quisquater, 76
 - knowledge extractor, 67, 95, 111
 - of the Fiat-Shamir type, 79
 - Schnorr, 73
 - signed, 80
 - soundness, 67
 - witness-hiding, 69
 - witness-indistinguishable, 68–69
 - zero-knowledge, 68
 - honest-verifier, 68
- protocol, 44
 - accepting view, 45
 - arbitrary composition of, 46, 69
 - certificate issuing, 32, 131–179
 - certificate showing, 33, 37, 91–130
 - generic description of, 71, 98, 113, 115, 202
 - immunization, 162–171
 - move, 44
 - round, 44
 - transcript, 45
 - verification relation, 44
 - view, 45
 - witness-indistinguishable, 68–69
 - zero-knowledge, 68
 - honest-verifier, 68
- pseudonymous certificates, 25, 26
 - drawbacks of, 26
 - PEM, 4
 - PGP, 26
 - SDSI, 12, 22, 26
 - X.509v3, 26
- pseudorandom generator, 249
- public key, 66
 - one-time, 200
 - self-certified, 88
- public key infrastructure, 3
- public-key certificate scheme, 86
- random oracle model, 49, 50, 58, 80, 84
- REFEREE, 12
- refreshing a certificate, 190
- remote lending, 251–252
- repeated squaring, 51, 56
- reputation, 7, 8, 26, 189, 211
- restrictive blinding, 131–179
- returning a certificate, 250–251
- revocation, 13–15, 17, 20, 23, 38
 - CRL, 13, 17, 23, 209, 210, 250, 253
 - delta-CRL, 13
 - drawbacks of, 14
 - online validation, 13
- round, 44
- RSA
 - function, 56–58
 - signature scheme, 87
- RSA-representation, 63
 - proving knowledge of, 75–76
 - trivial, 63
- RSAREP function, 62–65
 - compared to DLREP function, 65–66
 - proof of knowledge for, 75–76
- running time, 43
 - polylogarithmic, 80n

- superpolynomial, 43n
- S/MIME, 4
- Schnorr proof of knowledge, 73
- Schnorr signature scheme, 83
- SDSI, 12, 22, 26
- secret key, 66
- secret-key certificate scheme, 87
 - delegation strategy in, 185–189
 - simulator in, 87
- security
 - long-term, 201, 207
 - parameter, 42
 - reduction, 48–49
 - exact, 48
 - optimal tightness, 48
 - overhead factor, 48
 - tight, 48
- self-certified public key, 88
- self-regulation, 259–262
- SET, 4, 18, 27, 248
 - C-SET, 18
- short-lived certificate, 13, 15, 19, 38, 190
- showing protocol, 33
 - t out of u , 128
 - adaptively chosen formula attack, 96
 - Boolean formula, 119–128
 - interval enclosure, 129–130
 - linear inequality, 108–119
 - linear relation, 93–108
 - polynomial relation, 129
 - with selective disclosure, 27, 31, 35, 91–130
- signed message, 77
- signed proof, 80, 102
 - unforgeability of, 77
 - unmodifiability of, 101
- simulator
 - in secret-key certificates, 87
 - in zero-knowledge proofs, 68, 100
- simultaneous repeated squaring, 62, 63
- Smart Cards for Windows, 225
- smartcard, 15–19, 38, 219–255
 - anonymous issuing of, 252–253
 - low-cost, 225, 248–250
 - non-privacy dangers of, 19, 223–224
 - physical attacks, 29, 228, 253
 - privacy dangers of, 24, 219–223
 - security advantages of, 16–18
 - Smart Cards for Windows, 225
 - standardization
 - OpenCard Framework, 225
 - PC/SC Workgroup, 225
 - tamper-resistance, 223, 228
 - with cryptographic coprocessor, 248
 - performance of, 248
- smartcard-only paradigm
 - drawbacks of, 219–224
- software-only computing device, 15, 225
- soundness (of proof of knowledge), 67
- SPKI, 12, 22, 27
- SPKI/SDSI 2.0, 15
- status (of a formula), 96
- subliminal channel, 37, 221, 227
 - inflow, 222, 239–240
 - outflow, 222, 240–242
- sufficiently strong one-way function, 84
- superpolynomial running time, 43n
- surveillance, 20
- system parameters, 66
 - properly formed, 54, 57, 70
- tamper-resistant computing device, 16–18, 220, 221
 - iButton, 18
 - smartcard, *see* smartcard
- timing channel, 221, 244
- TLS, 12

- Tokeneer, 12, 19
- traceability, 28, 31, 226, 228, 253
- transcript (of protocol), 45
- trust management system
 - PolicyMaker, 11
 - REFEREE, 12
- uncertainty (non-negligible), 73
- unforgeability of signature scheme, 77
- unlimited-show certificate, 35, 208, 234
- unlinkability, 26, 30, 31, 189, 190, 212, 253
 - self-revocable, 266
- unmodifiability (of signed proof), 101
- untraceability, 28, 31, 226, 228, 253
 - self-revocable, 266
- updating a certificate, 191
- van Eck effect, 24, 221, 226
- vector addition chain, 62
- verification relation, 44
 - compound, 82, 205–207
- view, 45
 - accepting, 45
 - aggregate, 47
- witness
 - extractor, 69
 - initial, 71
- witness-hiding proof of knowledge, 69
- witness-indistinguishable protocol, 68–69
- X.500, 4, 210
- X.501, 9
- X.509, 3, 210
 - ACES, 4, 13, 18, 25
 - extensions, 12
 - Fortezza, 4, 18
 - FPKI, 4, 24, 270
 - PEM, 4
 - PKIX, 4, 13
 - S/MIME, 4
 - SET, 4, 18, 27, 248
 - C-SET, 18
 - version 1, 4, 13
 - version 2, 4, 13
 - version 3, 4, 10, 12, 13, 210
- X9, 7
 - X9.55, 4
 - X9.57, 12
- zero-knowledge, 68
 - honest-verifier, 68
 - simulator, 68, 100
- zeroization, 16