\*-property (star property), 255–256 1 x 1 GIF. *See* Web bugs. 12-step password attacks, 226 802.11 (wireless) standards, 383, 467

A1, TCSEC class, 297-298, 299-300 Acceptance testing, 170-171 Access acceptability, databases, 337-338 Access control databases, 325, 327-328 e-mail. 636 file protection all-none, 215-216 group, 216-217 individual permissions, 217 per-object, 219 persistent permissions, 218 per-user, 219 SUID (set userid), 218-219 temporary acquired permissions, 218-219 memory and address protection base/bounds registers, 195-196 context switch, 195-196 fences, 193-194 page frames, 202 paging, 202-203, 203-204 relocation, 194-195 relocation factor, 195 segment address table, 199 segmentation, 199-202, 203-204 selective protection. See Tagged architecture. tagged architecture, 196-199 principles of trusted systems, 266 privacy in computing, 606

privacy principles and policies, 618 protected objects AS (authentication server), 213-214 access control matrix, 210-211 ACLs (access control lists), 208-210 capability, 210-213 directories, 205-208 domains, 211 erasing deleted files, 207 KDC (key distribution center), 213-214 Kerberos, 213-214 local name space, 211 procedure-oriented, 214-215 protection goals, 205 pseudonyms, 207-208 revocation of access, 206-207 role-based, 215 single sign-on, 214 TGS (ticket-granting server), 213-214 types of, 204-205 wild cards, 208-210 Access control matrix, 210–211 Access decisions, databases, 337-338 Access policy ambiguity, 288 Access triples security policy, 250 Accountability principle, 272 Accuracy cost of security, 581 of information, ethical issues, 706-707 ACK (acknowledgment), 429

ACLs (access control lists), 208-210, 464-466 ACM (Association for Computing Machinery), code of ethics, 710, 712 Acquisti, Alessandro, 597 Acrobat PDF, deleting text, 271 Action phrases, 301 Active code, network threat, 433, 435-437 Active fault detection, 172-173 Active server pages (ASP), 435 Active wiretapping, 409 ActiveX controls, 435-437 Add subkey, 753 Addresses (IP). See IP addresses. Addresses (memory). See Memory and address protection. Adequate protection principle, 17 Adjusting future earnings, 575–576 Administering security. See Physical security; Risk analysis; Security plan; Security policies. Advertising, web privacy, 628-629 Adware, 633-634 AES (Advanced Encryption System). See also DES. add subkey, 753 byte substitution, 750-751 cryptanalysis of, 753-754 definition, 72 versus DES, 73-75 design contest, 72 MARS algorithm, 748 mix column, 752-753 RC6 algorithm, 749 Rijndael algorithm, 73, 749

815

AES (Advanced Encryption System). (continued) Serpent algorithm, 749 shift row, 751-752 structure of, 749-753 symmetric encryption, 748-754 Twofish algorithm, 749 Affected subject, 605-606 Agents, malicious, 114 Aggregation of data, 350-351, 625-626 AH (authentication header), 455 Airport security, case study, 370 Al Qaeda computer case study, 24 Alarms, 468, 489. See also Alerts. ALE (annualized loss expectation), 544 Alerts, 468. See also Alarms. Algebra, Euclidean, 726 Algorithm design, DES, 742-743 Algorithms, encryption. See Encryption, algorithms. Aliasing errors, 103 All-none file protection, 215–216 Allocation of general objects, 266-267 Amateur computer criminals, 21-22 Ambiguous access policies, 288 Amplifiers, network, 383 Analog network communication, 382 Analysis, risk. See Risk analysis. Ancheta, Jeanson James, 403 Anderson, Ross, 296, 351, 601, 622 Angle of dispersion, 384-385 Annualized loss expectation (ALE), 544 Anomaly-based intrusion detection, 485 Anonymity, 397, 614 Anonymization, 618, 622-623 Anonymous e-mail, 637-638 Antipiracy feature, 653-654 Antón, Annie, 645 Appended viruses, 118 Applets, hostile, 436, 499 Application layer, 386, 391 Application proxy gateways, 478-480 Applications code errors, 426 security. See Programs, security. viruses, 124 Architecture, networks, 442-443 Arithmetic properties of cryptography, 725-730 Arora, Ashish, 598

ARPANET, 112, 325 AS (authentication server), 213-214 ASINTOER code, 59 ASP (active server pages), 435 Asperger syndrome, 401 Assertions, 293 Assessment quality. See Evaluation. risk. See Risk analysis. Asset identification, 526-527 Association for Computing Machinery (ACM), code of ethics, 710, 712 Associativity, 727 Assurance. See Trusted systems, assurance. Assurance arguments, 184 Asymmetric encryption. See also Public key encryption; RSA. authentication, 62 characteristics of, 757-758 cryptanalysis of knapsack algorithm, 764-765 definition, 39 flow diagram, 40 general knapsacks, 759-760 hard knapsacks, 763-764 key distribution, 62 key management, 62 knapsack decryption algorithm, 764-765 knapsacks, and modular arithmetic, 761-763 knapsacks, as cryptographic algorithms, 761-763 Merkle-Hellman knapsacks, 758-761, 766-767 overview, 62 relatively prime values, 762 RSA (Rivest-Shamir-Adelman), 767-772 simple knapsacks, 760-761, 763 superincreasing knapsacks, 760-761, 763-764 AT&T. 677 Attachment viruses, 117-119 Attackers. See also Crackers; Hackers. amateurs, 21-22 career criminals, 22-23 motives, 399-404 network threat, 399-404 psychological profile, 401 terrorists, 23-24 Attacks. See also Threats: Vulnerabilities.

attractive targets, 9 controls, 7 definition, 7 information leaks, 16 MOM (method, opportunity, motive), 8-9 reprocessing used data items, 18 sources, 588 types, 587 universities, as prime targets, 9 vulnerabilities, 6 Attacks, methods 12-step password attacks, 226 brute force. See Brute force attack. brute force password, 223 chosen plaintext, 66 ciphertext only, 65 cryptanalytic. See Cryptanalysis. cyber, 101-102 database inference combined results control, 348 concealing control, 347 controls for, 347-349 count attacks, 343-344 direct attack, 342-343 indirect attack, 343-350 limited response suppression, 347-348 linear system vulnerability, 346-347 mean attacks, 344 median attacks, 344-345 problem summary, 349-350 query analysis, 349 random data perturbation, 349 random sample control, 348-349 statistical inference attacks, 347 sum attacks, 343 suppression control, 347 tracker attacks, 345-346 denial of service. See DDoS; DoS. encrypted password file, 227-228 exhaustive password, 223 full plaintext, 65-66 logic bombs, 16 man-in-the-middle, 149 partial plaintext, 65-66 password 12-step process, 226 brute force, 223 encrypted password file, 227-228 exhaustive, 223 indiscreet users, 228-229 plaintext password list, 226

probability, 224 salt extension, 228 trial and error, 222 weak passwords, 224-227 probable plaintext, 66 salami definition, 19, 144 examples, 144-145 persistence of, 145 timing, 150 trapdoors, 16 Trojan horses, 16 viruses, 16 Attractive targets, 9 Attributes, 321, 620 Audience for security policies, 547-548 Audit trails, 618 Auditability of databases, 326 Audits data overload, case study, 273 log reduction, 272-273 principles of trusted systems, 272 Australian Computer Crime and Security Survey, 582 Authentication asymmetric encryption algorithms, 62 certificates, 87-89 Digital distributed, 460-461 distributed, 398 flaws, 103 mutual, 463 network vulnerabilities avoidance, 416-417 eavesdropping, 416 guessing passwords, 415-416 man-in-the-middle attack, 420 masquerade, 418-419 nonexistent authentication, 417 phishing, 419 session hijacking, 419-420 spoofing, 418 trusted authentication, 418 well-known authentication, 417-418 wiretapping, 416 nonexistent, 417 privacy in computing anonymized records, 622-623 attributes, 620 identity, 619, 621-622 individual, 619, 620 meaning of, 619-620 overview, 619

privacy principles and policies, 617 strong, networks, 459-464 symmetric encryption algorithms, 62 trusted, network vulnerability, 418 users. See User authentication. Authentication header (AH), 455 Authentication server (AS), 213-214 Authenticity, databases, 338 Automatic exec by file type, 437 Availability of data data and services, 12 data mining, 370 databases, 328-329 definition, 10 denial of service. See DDoS; DoS. Avoidance, 416-417 B1, TCSEC class, 297-298, 299 B2, TCSEC class, 297-298, 299 B3, TCSEC class, 297-298, 299 Backdoors. See Trapdoors. Backing up data, 563-566 Balanced scorecard, 573-574 Base registers, 195-196 Baseline, 244 Bastion host, 478-480 Beacon gif. See Web bugs. Beizer. Boris, 678 Bell-La Padula security model, 254-256 Beneficiaries of security policies, 548 Benign viruses, 132-133 Best practices, 34, 568 BestBuy, 413 Biba integrity security model, 256 BIND (Berkeley Internet Name Domain), 431 Binding of functionality, 304 Biometrics, 219-220, 234-236. See also Face recognition authentication. "Black hole" failure, 325 Black-box testing, 170 Blaze, Matt, 677 Block ciphers, 62-63. See also AES; DES Bombs, software. See Logic bombs; Time bombs. Book ciphers, 52-54 Boot sector viruses, 122 Bootstrapping, 122 Botnets, 437-438 Bots, 437-438

#### Index 817

Boundaries, network, 381-382 Boundary condition errors, 103 Bounds disclosure, 338 Bounds registers, 195-196 Brain virus, 133-134 Breakable encryption, 42-43 Breaking encryption. See also Cryptanalysis. chosen plaintext attacks, 66 ciphertext only attacks, 65 full plaintext attacks, 65-66 partial plaintext attacks, 65-66 probable plaintext attacks, 66 weaknesses, 66-67 Britain. See United Kingdom. British evaluation criteria, 301-302 Broadcast mode, 428-429 Brute force attack, 223, 744-745 Buffer overflow, 178, 425 Bugs software, 100 web, 10\$631, 139-141 Bulletin boards, 407 Business case adjusting future earnings, 575-576 balanced scorecard, 573-574 cost estimates, 578 definition, 573 determining economic value, 574-578 discount rate, 576 false positives, 578 influences on investment strategy, 572 IRR (internal rate of return), 577 net present value, 574-577 opportunity cost, 576 overview, 572-574 ROI (return on investment), 577-578 web application, case study, 579 Business continuity plan, 518-521 Byte substitution, 750-751 C1, TCSEC class, 297-298 C2, TCSEC class, 297-298, 299 Cables, network coaxial, 382 eavesdropping, 409-410 Ethernet, 383

Ethernet, 383 impedance, 410 inductance, 409 networking, 382–383 UTP (unshielded twisted pair), 382 wiretapping, 409–410

Caesar cipher, 44-46 California Breach Act, 686 CAN (campus area network), 395 CAN SPAM Act, 685-686 Capability, 210-213 Capability Maturity Model (CMM), 181 Capstone, 691 Career computer criminals, 22-23 CartManager International, 612 CARVER (criticality, accessibility, recuperability, vulnerability, effect, and recognizability) method, 530 Case studies airport security, 370 al Qaeda computer, 24 analysis of Shakespeare's plays, 353 attacker profile, 401 "black hole" failure, 325 business case, 579 CartManager International, 612 computerized text analysis, 353 copyright, 655 data mining, 370 database integrity failure, 325 database precision, 341 deceptive practices, 612-613 difficulties of securing code, 140 Earl of Buckingham, 621 e-mail theft Hollywood, 20 New Zealand Herald, 413 Wilshire Associates, Inc., 28 ethical issues accuracy of information, 706-707 cracking, 707-710 DoS (denial of service), 701-702 fraud, 705-706 hacking, 707-710 ownership of programs, 702-704 privacy rights, 700-701 proprietary resources, 704 use of computer services, 698-699 FAIS (Foreign Affairs Information System), 312 hacker sting operation, 403 Hollywood e-mail theft, 20 human fallibility, 67 identity theft, 621 JetBlue airlines, 612-613 Kennedy, Edward, 370

Key Online Banking, 452 Lewis, John, 370 Lloyd's Bank, 452 mafia boss, 45 microcontrollers in automobiles, 3 MP3.com, 655 Napster, 655 online banking, 452 PKI (public key infrastructure), 452 privacy, 615 privacy, government intrusion Icelandic DNA database, 351 U.K. RIPA (Regulation of Investigatory Powers Act), 287 screening for terrorists, 615 security, as add-on, 312 silken codes, 41 Stopford, Charlie, 621 Torch Concepts, 612-613 tracking Russian nuclear weapons, 140 U.S. Government audit data overload, 273 security report card, 29 U.S Census Bureau, 341 V.A. (Veterans Administration), 14 Wilshire Associates, e-mail theft, 28 wireless vulnerabilities, 413 WW II ASINTOER code, 59 Enigma code machine, 67 Japanese codes, 42 poem codes, 48 silken codes, 41 Soviet Union codes, 59 Catastrophe, recovering from. See Backing up data; Physical security; Recovery from backup. CCB (configuration and change control board), 176 CDs (compact disks) copy protection, 145-147, 654-655 fair use, 654-655 XCP (extended copy protection) rootkit, 145-147 Census Bureau, 341 Centralization, 326-327 CERT (Computer Emergency Response Team), 432 Certificate authority, 8, 451 Certificates authentication, 87-89 encryption, 84-91 encryption, uses for, 84-91

trust through common respected individual, 85-87 without a single hierarchy, 89-91 trust threshold, 85 CGI (Common Gateway Interface), 434-435 Chain of custody, 680 Chaining, 80 Challenge, attack motive, 400 Challenge-response systems, 231-232, 233-234, 460 Change logs, 326 Change management. See Configuration. Channels, covert. See Covert channels. Chats, 407 Checksums, cryptographic definition, 79-80 multilevel databases, 358-359 networks, 458-459 Children's Online Privacy Protection Act (COPPA), 610 Chinese Wall security policy, 251-252 Chosen ciphertext attack, 66 Chosen plaintext attacks, 66 Ciphers block, 62-63. See also AES; DES. book, 52-54 Caesar, 44-46 complexity, 47-48 cryptanalysis, 48-49 cryptographer's dilemma, 49 keyless, 40 keys, 47 one-time pads, 50-54 permutations, 46-47 product, 58, 733 random number sequences, 50 RC2, 754-755 RC4, 755-756 RC5, 756 stream, 62-63 substitution book ciphers, 52-54 Caesar cipher, 44-46 complexity, 47-48 cryptanalysis, 48-49 cryptographer's dilemma, 49 keys, 47 one-time pads, 50-54 permutations, 46-47 random number sequences, 50 Vernam cipher, 50-52

Vignère tableau, 50, 53 Vernam, 50–52 Vernam cipher, 50-52 Vignère tableau, 50, 53 Ciphertext, 26, 39 Ciphertext only attacks, 65 Civil law, 667 Claims language, 301 Clark-Wilson commercial security policy, 250 Classical probability, 534 Classification, 248 Clear gif. See Web bugs. Clear-box testing, 170-171 Cleartext, 26. See also Plaintext. CLEFs (Commercial Licensed Evaluation Facilities), 302 Clients, network, 378-379 Clipper, 691. See also Keys (encryption), escrow. Clique problem, 720-722 Closed versus open organizations, 595 Clustering, key, 746 CMM (Capability Maturity Model), 181 Coaxial cable, 382 Code (program) compatibility, 198-199 debugging, 142. See also Testing. error correcting, 458 errors, 426 inspection, 166 malicious. See Malicious code. mobile, 433 review, 168 security. See Programs, security. signing, 457, 501 walk-through, 166 Code Red worm, 137-139, 675-676 Codes (encoding systems). See also Cryptography; Encryption. hash, 458 Huffman, 458 Japanese, 42 poem, 48 silken, 41 Soviet Union, 59 Codes (of conduct) of best practice. See Best practices. of ethics. See Ethics. Cohesion, 163 Cold site backups, 565 Columnar transpositions, 55-58 Combined Federal Criteria, 304-307

Combined results control, 348 Command insertion, 142 Command structure, 259 Commercial Licensed Evaluation Facilities (CLEFs), 302 Commercial security policies, 248-250 Commit flag, 330 Commit phase, 331-332, 334 Committing database updates, 330 Common Criteria, 307-308 Common Gateway Interface (CGI), 434-435 Common Intrusion Detection Framework, 484 Communication mode, networks, 382 Community string, 418 Commutative filters, 361-363 Commutative ring, 727-728 Comparability, evaluating, 303 Comparable data, data mining, 369 Compartments, 246 Compatibility of code, 198-199 evaluation, 309 Complements, DES, 745 Complete backups, 564 Complete mediation, 265-266, 270. See also Incomplete mediation. Complex attacks, 438 Component testing. See Unit testing. Components, software. See Modularity. Composites, 725 Computational complexity, cryptography, 718 Computer crime definition, 21 legal issues California Breach Act, 686 CAN SPAM Act, 685-686 computer terminology and the law. 681 confidentiality threats, 680 Council of Europe Agreement on Cybercrime, 687 cryptography, 688, 688-692 defining, 681-682 E.U. Data Protection Act, 687 GLBA (Graham-Leach-Bliley Act), 684 HIPAA (Health Insurance Portability and Accountability Act), 684-685

#### integrity threats, 680 international dimensions, 686-688 overview, 679 prosecuting, 682-683 restricted content, 687-688 rules of evidence, 680 rules of property, 679-680 scope limitations, 688-689 statutes, examples, 683-686 U.S. Computer Fraud and Abuse Act, 683 U.S. Economic Espionage Act, 683 U.S. Electronic Communications Privacy Act, 684 U.S. Electronic Funds Transfer Act, 683 U.S. Freedom of Information Act, 684 U.S. Privacy Act, 684 USA Patriot Act, 685 value of data, 681 reporting, 21 statistics, 21 Computer criminals. See Attackers; Crackers; Hackers. Computer Emergency Response Team (CERT), 432 Computer Ethics Institute, 710, 713 Computer Fraud and Abuse Act, 683 Computer objects. See Objects, digital. Computer screen emanations, 562-563 Computer terminology and the law, 681 Computerized text analysis, 353 Computing systems components of, 6 definition, 4 intrusion characteristics, 4-5 Concealing control, 347 Concurrency, 333 Conditional compilation, 175 Conditions, security models, 259 Confidence level, 244 Confidentiality. See also Privacy. data, 17, 19 databases, 329 definition, 10 e-mail, 492-493 multilevel databases, 355 overview, 11 threats, 680

#### Index

819

Configuration audit, 175-176 databases, 327 identification, 175 management, 174-176 Configuration and change control board (CCB), 176 Confinement, 165 Confusion, 63-64, 730 Connection flooding, 427-428 Connectivity. See Networks. Consequence-based ethics, 696-697 Consistency, database, 332, 333 Constrained data items, 250 Constraints, 512-514 Consumer products, privacy, 639-640 Content integrity, 457-459 Contests, web privacy, 629 Context switch, 195-196 Contingency planning. See Physical security; Risk analysis; Security plan. Continuity plan, 518-521 Contract law, 668-669 Control, network, 381–382 Controlled disclosure, 604 Controls. See also Defense methods. data protection. See Encryption. database inference attacks, 347-349 definition, 7 effectiveness, 28-30 export of cryptography, 690 hardware, 27 layered defense, 29 mapping to vulnerabilities, 537 for networks. See Networks, controls. overlapping, 29 overview, 24-25 physical, 27 policies and procedures, 27 security plan, 512-514 selecting criteria for, 537-542 mapping controls to vulnerabilities, 537, 539 positive and negative effects, 538-541 ratings, 541-542 VAM (Vulnerability Assessment and Mitigation), 537-542 software, 26-27 software development acceptance testing, 170-171 active fault detection, 172-173

black-box testing, 170 CCB (configuration and change control board), 176 clear-box testing, 170-171 CMM (Capability Maturity Model), 181 components. See Modularity. conditional compilation, 175 configuration audit, 175-176 configuration identification, 175 configuration management, 174-176 confinement, 165 coupling, 163 delta files, 175 design principles, 172-173 developer characteristics, 160-161 development standards, 178, 180 difference files, 175 encapsulation, 161-164 FMEA (failure modes and effects analysis), 168-169 formal methods, 179 FTA (fault tree analysis), 168-169 genetic diversity, 165 hazard analysis, 168-169 HAZOP (hazard and operability studies), 168-169 independent testing, 172 information hiding, 161-164 installation testing, 170 integration testing, 170 lessons from mistakes, 176 modularity, 161-164 mutual suspicion, 164 nature of software development, 160-161 overview, 26-27 passive fault detection, 172-173 peer reviews, 165-168 penetration testing, 172, 177 performance testing, 170 problem response, 173 process standards, 180-181 program practice conclusions, 178 program verification, 177-178 proof of correctness, 177-178 redundancy, 173 regression testing, 170 risk prediction, 173-174 security audits, 180 security requirements, 171

static analysis, 174 status accounting, 176 testing, 169-172 tiger team testing. See Penetration testing. unit testing, 170 usage of cryptography, 688-690 Convention 108, 613 Cookies network threat, 434 per-session, 434 persistent, 434 threats posed by, 434 user authentication, 236 viruses, 140 web privacy, 629-631 COPPA (Children's Online Privacy Protection Act), 610 Copy protection, 145-147, 654-655 Copyright case study, 655 for computer software, 652-653 definition, 650 for digital objects, 653-655 DMCA (Digital Millennium Copyright Act), 649-650, 653 fair use, 651 first sale, 651 inappropriate references to, 656 infringement, 652 intellectual property, 650-651 legal issues, 649-655, 660 Napster, 655 originality of work, 651 ownership, 671 piracy, 651 public domain, 650 registering, 652 Core. See Kernel. Correcting mistakes, data mining, 369 Correction codes, database reliability, 332 Correctness of data, data mining, 368-369 Correlation of data, 624-625 Cost of security. See Economics of cybersecurity. Cost/benefit risk analysis, 544 Council of Europe, 613 Council of Europe Agreement on Cybercrime, 687 Count attacks, 343-344 Coupling, 163 Covert channels creating, 152

definition, 150 file lock channel, 152 identifying, 156-158 information flow analysis, 158 overview, 151-152 shared resource matrix, 157-158 signaling through images, 159-160 steganography, 159-160 storage channels, 152-155 threat presented by, 158-160 timing channels, 155-156 Crackers, 22. See also Attackers; Hackers. Cracking, ethical issues, 707-710 Credibility, 592 Credit card payments, web privacy, 627 Crime. See Computer crime. Criminal law, 667 Criteria development, 309-311 Criticality, accessibility, recuperability, vulnerability, effect, and recognizability (CARVER) method, 530 Cryptanalysis AES (Advanced Encryption System), 753-754 breaking encryption chosen plaintext attacks, 66 ciphertext only attacks, 65 full plaintext attacks, 65-66 partial plaintext attacks, 65-66 probable plaintext attacks, 66 weaknesses, 66-67 Caesar cipher, 45-46 definition, 41 differential, 71-72, 747-748 digram analysis, 57-58 knapsack algorithm, 764-765 overview, 41-42 RSA (Rivest-Shamir-Adelman) encryption, 772 substitution ciphers, 48-49 Cryptanalysts, 40 Cryptographers, 40 Cryptographer's dilemma, 49 Cryptographic challenges RSA (Rivest-Shamir-Adelman) encryption, 772-773 symmetric encryption, 756-757 Cryptographic checksum definition, 79-80 multilevel databases, 358-359 networks, 458-459 Cryptographic hash functions, 79-80

Cryptographic separation, 192, 279-280 Cryptography. See also Encryption. asymmetric encryption characteristics of, 757-758 cryptanalysis of knapsack algorithm, 764-765 general knapsacks, 759-760 hard knapsacks, 763-764 knapsack decryption algorithm, 764-765 knapsacks, and modular arithmetic, 761-763 knapsacks, as cryptographic algorithms, 761-763 Merkle-Hellman knapsacks, 758-761, 766-767 relatively prime values, 762 RSA (Rivest-Shamir-Adelman), 767-772 simple knapsacks, 760-761, 763 superincreasing knapsacks, 760-761, 763-764 Capstone, 691 character representation, 43-44 ciphertext, 39 Clipper, 691 computer crime, 688, 688-692 current policy, 691-692 decryption, 38 definition, 40 DSA (Digital Signature Algorithm), 773-774 El Gamal algorithm, 773 encrypted text, 39 encryption, 38 export controls, 690 Fortezza, 691 and free speech, 690-691 interceptors, 38 intruders, 38 key escrow, 691 legal issues, 688-692 mathematics of arithmetic properties, 725-730 commutative ring, 727-728 composites, 725 computational complexity, 718 division, 725 Euclidean algebra, 726 Fermat's theorem, 729-730 Galois fields, 727-728 greatest common divisor, 726 hierarchies of complexity, 723 identity (mathematical), 725

#### Index 821

inherently hard problems, 724-725 instances, 722 inverses, computing, 728-730 inverses, definition, 725 knapsack problem, 719-720 modular arithmetic, 726-728 nondeterminism, 721 nondeterministic Turing machines, 721 NP class, 721 NP-complete problems, 719-724 oracles, 721 overview, 718 P class, 721 prime numbers, 725 problems, definition, 722-723 satisfiability, 719 modular arithmetic, 43 original text, 39 perfect cipher. See One-time pads. permutations columnar transpositions, 55-58 combined approaches, 58 definition, 55 digram analysis, 57-58 digrams, 56-57 encipherment/decipherment complexity, 56 patterns, 56-57 product ciphers, 58 substitution ciphers, 46-47 trigrams, 56-57 with photons, 775-776 plaintext, 39 quantum cryptography with photons, 775-776 implementation, 776-778 overview, 774 photon reception, 775 polarizing filters, 774-775 quantum physics, 774-775 recipients, 38 senders, 38 substitution ciphers book ciphers, 52-54 Caesar cipher, 44-46 complexity, 47-48 cryptanalysis, 48-49 cryptographer's dilemma, 49 keys, 47 one-time pads, 50-54 permutations, 46-47 random number sequences, 50

Cryptography (continued) substitution ciphers (continued) Vernam cipher, 50-52 Vignère tableau, 50, 53 substitutions, 43 symmetric encryption. See also DES. AES (Advanced Encryption System), 748-754 confusion, 730 cryptographic challenges, 756-757 diffusion, 730 permutation, 730 problems with, 730-732 RC2 cipher, 754-755 RC4 cipher, 755-756 RC5 cipher, 756 substitution, 730 transmission medium, 38 transpositions. See Permutations. usage controls, 688-690 Cryptology, 40 Cryptosystems, 38 CSI/FBI Computer Crime and Security Survey, 582 Culp, Scott, 675-676 Culture of organizations. See Organizational culture. Cyber attacks, 101-102 CyberCop Scanner, 405 Cyberterrorism, 403 Cycle, DES details, 736 example, 735 permutation, 734 substitution, 734 D, TCSEC class, 297-298 DAC (discretionary access control), 269 - 270Daemen, John, 72 Danseglio. Mike, 22 Data. See also Information. access risks, 617 anonymization, 618 availability, databases, 337 form checks, database, 334 justifying cost of security accuracy, 581 consistency, 581 reliability, 581 representative, 586 left in place, 618 minimization, 617-618

perturbation data mining, 624-626 database attacks, 349 database inference, 349 privacy, 624-626 random, 349 secrecy. See Confidentiality; Privacy. semantics, data mining, 369 sensitivity, 551 stored, protecting, 609-610 Data Encryption Algorithm (DEA), 69. See also DES. Data Encryption Algorithm-1 (DEA-1), 69. See also DES. Data mining. See also Databases. case study, 370 comparable data, 369 correcting mistakes, 369 data availability, 370 data correctness, 368-369 data semantics, 369 definition, 367 eliminating false matches, 370 integrity, 368-369 overview, 367 privacy aggregation of data, 625-626 correlation of data, 624-625 data perturbation, 624-626 government, 624 preserving privacy, 624-626 sensitivity, 368 Data Protection Act, 687 Database administrators, 319, 515 Database management system (DBMS), 319 Databases. See also Data mining. advantages of, 323 aggregation, 350-351. See also Inference. attributes, 321 components of, 319-323 decentralization, 373 definition 319 deleting fields and records. See Queries. editing fields and records. See Queries. elements, 319 fields, 319 front end. See DBMS. inference. See also Aggregation. combined results control, 348 concealing control, 347

controls for, 347-349 count attacks, 343-344 definition, 341 direct attack, 342-343 indirect attack, 343-350 limited response suppression, 347-348 linear system vulnerability, 346-347 mean attacks, 344 median attacks, 344-345 problem summary, 349-350 query analysis, 349 random data perturbation, 349 random sample control, 348-349 statistical inference attacks, 347 sum attacks, 343 suppression control, 347 tracker attacks, 345-346 logical structure, 320 manipulating. See Queries. protection laws, 666 queries, 321-323 records definition, 319 manipulating. See Queries. projecting, 321-323 selecting, 321-323 relations, 321 reliability commit flag, 330 committing updates, 330 concurrency, 333 consistency, 332, 333 correction codes, 332 data form checks, 334 definition, 329 error detection, 332 filters, 334 intent phase, 330 monitors, 334-335 operating system protection features, 329-330 patterns, 334 recovery from backup, 332 redundancy, 332 shadow fields, 332 shadow values, 331-332 state constraints, 334-335 transition constraints, 335 two-phase update, 330-332 retrieving fields and records. See Queries. schema, 320 security requirements

access control, 325, 327-328 auditability, 326 availability, 328-329 change logs, 326 confidentiality, 329 configuration management, 327 field checks, 325 inference, 328 integrity, 324-326, 329 pass-through problem, 326 release proliferation, 327 user authentication, 328 version proliferation, 327 sensitive data access acceptability, 337-338 access decisions, 337-338 authenticity, 338 bounds disclosure, 338 characteristics of, 336-337 data availability, 337 definition, 335 disclosures, types of, 338-339 exact data disclosure, 338 existence disclosure, 339 negative result disclosure, 339 overview, 335-337 probable value disclosure, 339 security versus precision, 339-341 subschema, 320 Databases, multilevel confidentiality, 355 differentiated security, 352-353 duplicate records, 355 granularity, 353 integrity, 354 polyinstantiation, 355 redundancy, 355 security designs commutative filters, 361-363 distributed databases, 363 federated databases, 363 filtering, 365 guards, 360-361 integrity locks, 359-360 practical issues, 366 trusted front-end, 360-361 views, 363-366 windows, 363-366 security issues, 354-355 security proposals cryptographic checksum, 358-359 encryption, 356-357 integrity lock, 357-359

partitioning, 356 sensitivity lock, 359 separation, 356-359 "spray paint" lock, 357-359 Summer Study on Database Security, 357 Datagrams, 391 DBMS (database management system), 319 DDoS (distributed denial of service). See also Availability; DoS. diagram of, 433 network threat, 431–433 TFN (Tribal Flood Network), 401, 432 TFN2K, 401, 432 de Vere, Edward, 353 DEA (Data Encryption Algorithm), 69. See also DES. DEA-1 (Data Encryption Algorithm-1), 69. See also DES. Debugging code, 142. See also Testing code. Decentralization, databases, 373 Deceptive practices, 612-613 Deciphering data. See Decryption. Decision making, 590-592 Decoding data. See Decryption. Decryption algorithm, 764-765 definition, 38 DES (Data Encryption Standard), 742 knapsacks, 764-765 Defacing web sites, 424-425 Defense methods. See also Controls. privacy principles and policies, 617-618 viruses, 129-131 Defining computer crime, 681-682 Degaussing magnetic data, 562. See also Magnetic remanence. Deleting database fields and records. See Queries. PDF text, 271 Word text, 271 Deloitte and Touche Tohmatsu Global Security Survey, 582-583 Delphi approach, 533-534 Delta (configuration control method), 175 Denial of service (DoS). See DoS (denial of service). Deontology, 697

#### Department of Energy (DOE) policy, 551-552 Department of Trade and Industry (DTI), 18 Depletion of information, 663 DES (Data Encryption Standard). See also AES. versus AES, 73-75 algorithm design, 742-743 background, 68-69 brute force attack, 744-745 complements, 745 cycle, example, 735 cycle details, 736 decryption, 742 design weaknesses, 746 differential cryptanalysis, 71-72, 747-748 double DES, 70-71 encryption algorithm, 733-736 expansion permutations, 733, 736-741 final permutation, 739, 741 history, 68-69 initial permutation, 739, 741 inverse initial permutation, 739, 741 key clustering, 746 key length, 743-745 key transformation, 736 Lucifer algorithm, 68-69 number of iterations, 743 overview, 69-70, 732-733 parallel attack, 744-745 P-boxes, 739, 741 permutation cycle, 734 permutation types, 736 permuted choices, 733 product cipher, 733 S-boxes, 739, 740 security of, 71-72, 742-745, 748 semiweak keys, 745-746 substitution cycle, 734 triple DES, 71 weak keys, 745 weaknesses, 745-748 Destination unreachable protocol, 438 Determining economic value. See Economics of cybersecurity. DHCP (Dynamic Host Configuration Protocol), 412 Diamond v. Bradley, 658 Diamond v. Diehr, 658 Difference files, 175 Differential cryptanalysis, 71-72, 747-748

#### 823

Index

Differentiated security, multilevel databases, 352-353 Diffie-Hellman key exchange, 81-82 Diffusion, 63-64, 730 Digital distributed authentication, 460-461 Digital Equipment Corporation, 460-461 Digital Millennium Copyright Act (DMCA), 649-650, 653 Digital network communication, 382 Digital objects. See Objects, digital. Digital Signature Algorithm (DSA), 773-774 Digital Signature Standard (DSS), 773 Digital signatures, 82-84 Digram analysis, 57-58 Digrams, 56-57 Direct attack, 342-343 Directive 95/46/EC, 613 Directories, 205-208 "Dirty" power, 558 Disaster, natural. See Natural disasters. Disaster recovery. See Backing up data; Physical security; Recovery from backup. Disclosure bounds, 338 controlled, 604 exact data, 338 existence, 339 negative result, 339 privacy issues, 606 probable value, 339 of software problems, 675-676 types of, 338-339 Discount rate, 576 Discretionary access control (DAC), 269-270 Distributed authentication, 398 Distributed databases, 363 Distributed denial of service (DDoS). See DDoS. Division, cryptography, 725 DMCA (Digital Millennium Copyright Act), 649-650, 653 DNS attacks, 431 DNS cache poisoning, 431 Document viruses, 119-120 Documentation availability, network threat, 407 protection, legal issues, 662 DOE (Department of Energy) policy, 551-552 Domain errors, 103

Domain names, 393, 662 Domain switching, 276 Domains, 211 Dominance, 248 DoS (denial of service). See also Availability; DDoS. broadcast mode, 428-429 connection flooding, 427-428 DNS attacks, 431 DNS cache poisoning, 431 echo chargen, 428 estimated activity, 432 ethical issues, 701-702 network threat, 427-431 ping of death, 428 smurf attack, 428-429 SYN flood, 429 teardrop attacks, 430 traffic redirection, 430 transmission failure, 427 Dot-dot-slash directory travel, 425-426 Double DES, 70-71 DoubleClick, 630-631 Drive-by installation, 634 Drops, electrical, 558 DSA (Digital Signature Algorithm), 773-774 DSS (Digital Signature Standard), 773 DTI (Department of Trade and Industry), 18 Dumpster diving, 406-407 Dunham, Ken, 22 Duplicate database records, 355 Durability, 550 Dynamic Host Configuration Protocol (DHCP), 412 Earl of Buckingham, 621 Ease of use, 266

Ease of use, 266 Easiest penetration principle, 5 Eavesdropping, 408–414, 416 Echo chargen attack, 428 Echo protocol, 438 Economic Espionage Act, 683 Economics of cybersecurity business case adjusting future earnings, 575–576 balanced scorecard, 573–574 cost estimates, 578 definition, 573 determining economic value, 574–578 discount rate, 576

false positives, 578 influences on investment strategy, 572 IRR (internal rate of return), 577 net present value, 574-577 opportunity cost, 576 overview, 572-574 ROI (return on investment), 577-578 web application, case study, 579 current and future externalities, 599 free rides, 598 integrity, 598 policies, 597 regulation, 598-599 modeling credibility, 592 decision making, 590-592 framing the issue, 590-591 group behavior, 591-592 overview, 589 role of organizational culture, 592-597 transferring models, 589-590 trust as economic issue, 592 organizational culture cultural practices, 593-594 cultural values, 594 dimensions of, 595 employee versus job, 594 heroes, 593 loose versus tight control, 595 normative versus pragmatic, 595 open versus closed, 595 parochial versus professional, 595 process versus results, 594 rituals, 593 role of organizational culture, 592-597 security choices, examples, 596 symbols, 592 quantifying value accurate data, 581 attack sources, 588 attack types, 587 comparability of categories, 587 consistent data, 581 cost of U.K. security incidents, 586 economic impact, 580, 586, 588 ISBS (Information Security Breeches Survey), 581, 585-586

justification data, 580-581 overview, 578-580 reliable data, 581 representative data, 586 respondent types, 587 security practices, 581, 585-586 timelines, 581 security surveys Australian Computer Crime and Security, 582 CSI/FBI Computer Crime and Security, 582 Deloitte and Touche Tohmatsu Global Security, 582-583 Ernst and Young Global Information Security, 583-584 IC3 (Internet Crime Complaint Center), 584 Imation Data Protection, 584-585 sources for, 585 trust, as economic issue, 593 Economics of security policies, 551 Economy of mechanism, 265 EEye Digital Security, 675-676 Effectiveness of controls, 28-30 evaluating, 303 Effectiveness principle, 28 Egoism, 696-697 e-Government Act of 2000, 611 802.11 (wireless) standards, 383, 467 El Gamal algorithm, 773 Electrical power, 558-559 Electronic commerce, laws, 666-667 Electronic Communications Privacy Act, 684 Electronic Funds Transfer Act, 683 Electronic publishing, laws, 666 Electronic voting, 641-642 Elements, databases, 319 E-mail attachment viruses, 117-118 government security policy example, 553 network encryption, 457 over networks. See Networks, secure e-mail. privacy access control, 636 anonymous, 637-638 interception, 636 mixmaster remailers, 637-638 monitoring, 637 overview, 635

remailers, 637-638 simple remailers, 637 spamming, 638 spoofing, 638 transmitting, 636 theft case studies Hollywood, 20 New Zealand Herald, 413 Wilshire Associates, Inc., 28 Emanations from computer screens, 562-563 Emerging technologies consumer products, 639-640 electronic voting, 641-642 overview, 638-639 privacy issues, 640-641 RFID (radio frequency identification), 640 security issues, 640-641 Skype, 642 VoIP (Voice over IP), 642 Emphatic assertion, 311 Employee contracts, 672 Employee rights. See Rights of employees and employers. Employee versus job, 594 Employer rights. See Rights of employees and employers. Encapsulated security payload (ESP), 455 Encapsulation, 161-164 Enciphered text, 26 Enciphering data. See Cryptography; Encryption. Encipherment/decipherment complexity, 56 Encoding data. See Cryptography; Encryption. Encrypted password file attacks, 227-228 Encrypted tunnels, 449-450 Encryption. See also Asymmetric encryption; Cryptography; Symmetric encryption. algorithms. See also AES; DES; RSA. block ciphers, 62-63 confusion, 63-64 definition, 39 diffusion, 63-64 secure, characteristics of, 60-62 stream ciphers, 62-63 trustworthy, properties of, 61-62 breakable, 42-43 breaking. See Cryptanalysis.

#### ciphertext, 26 cleartext, 26 cryptosystems, 38 definition, 26, 38 e-mail, 493-494 enciphered text, 26 factoring large numbers, 78, 325-330 key management, 62 keyless ciphers, 40 keys, 39 link, 445-446 multilevel databases, 356-357 networks AH (authentication header), 455 certificate authorities, 451 comparison of methods, 447-449 e-mail, 457 encrypted tunnels, 449-450 end-to-end, 446-447 ESP (encapsulated security payload), 455 firewalls, 449-450 IKE (ISAKMP key exchange), 455-456 ISAKMP (Internet Security Association Key Management Protocol), 455 issues, 453 link, 445-446 overview, 444-445 PKI (public key infrastructure), 450-453 security associations, 454-455 signed code, 456-457 SPI (security parameter index), 455 SSH (secure shell), 453 SSL (Secure Sockets Layer), 453-454 TLS (transport layer security), 453-454 tunnels, 449-450 VPNs (virtual private networks), 449-450 private key, 39-40. See also AES; DES; Symmetric encryption. protocols, 26 public key. See also Asymmetric encryption; RSA. characteristics, 77 definition, 39 flow diagram, 40 key proliferation, 77

purpose of, 76

Index

825

Encryption (continued) text, 39 uses for certificates, 84-91 chaining, 80 checksums, 79-80 cryptographic checksum, 79-80 cryptographic hash functions, 79-80 Diffie-Hellman key exchange protocol, 81-82 digital signatures, 82-84 key exchange, 80-82 End-to-end encryption, 446-447 Enforced sharing, 267 England. See United Kingdom. Enigma code machine, 67 Equivalent programs, 128 Erasing deleted files, 207 Ernst and Young Global Information Security Survey, 583-584 Error checking, trapdoors, 142-143 Error correcting codes, 458 Error detection, 332, 458 Errors. See also Faults; Flaws. buffer overflow, 178, 425 definition, 100 incomplete mediation. See Incomplete mediation. privilege escalation, 147-148 time-of-check to time-of-use flaws, 288 Escape-character attack, 434-435 ESP (encapsulated security payload), 455 Espionage, 402, 683 Estimating security value. See Economics of cybersecurity. Ethernet cable, 383 Ethical codes, 710-713 Ethical hacking. See Penetration testing. Ethical issues. See also Legal issues. a case for, 696 case studies accuracy of information, 706-707 cracking, 707-710 DoS (denial of service), 701-702 fraud, 705-706 hacking, 707-710 ownership of programs, 702-704 privacy rights, 700-701 proprietary resources, 704 use of computer services, 698-699

overview, 647-649 Ethical pluralism, 695 Ethical principles consequence-based, 696-697 deontology, 697 duties of people, 697-698 egoism, 696-697 examples of, 696-698 intrinsic good, 697-698 rule-based, 697-698 rule-deontology, 697-698 teleological theory, 696-697 utilitarianism, 697 Ethical reasoning, 695-698 Ethical systems, 693 Ethics versus law, 692-694 and religion, 694 studying, 693-695 universality, 694-695 E.U. Data Protection Act, 687 Euclidean algebra, 726 Euler totient function, 769-771 European Privacy Directive, 613 Evaluating security value. See Economics of cybersecurity. Evaluation action phrases, 301 British criteria, 301-302 claims language, 301 CLEFs (Commercial Licensed Evaluation Facilities), 302 Combined Federal Criteria, 304-307 Common Criteria, 307-308 comparability, 303 criteria development, 309-311 effectiveness, 303 emphatic assertion, 311 Europe, 300-303 German Green Book, 300-301 ITSEC (Information Technology Security Evaluation Criteria), 300-303, 303-304 marketability, 303 overview, 296-297 process description, 309 protection profiles, 305 security, as add-on, 312 security targets, 306 summary of criteria, 308-311 target phrases, 301 TCSEC (Trusted Computer System Evaluation Criteria), 297-300, 304 TOE (target of evaluation), 303

transferability, 303 United States, 297-300, 304-307 Even parity, 458 Evidence destroying, 523 gathering, 523 physical, 682 preserving, 523 rules of, 680 Exact data disclosure, 338 Examples of problems. See Case studies. Execution domain switching, 276 Executives, 189-190 Exhaustive password attacks, 223 Existence disclosure, 339 Expansion permutations, 733, 736-741 Exploitation examples, 289-290 Export controls in cryptography, 690 Exposing messages, 421-422 Extended copy protection (XCP) rootkit, 145-147 Externalities, 599 F1-F10 functionality classes, 301-303 Fabrications, 7-8 Face recognition authentication, 619. See also Biometrics. Factoring large numbers, 78, 725-730 Failover mode, 443 Failure, 100, 443-444 Failure modes and effects analysis (FMEA), 168-169, 528 Fair Credit Reporting Act, 610 Fair information policies, 609-610, 613-614 Fair service guarantee, 267 Fair use, 651 Fairbrother, Peter, 287 FAIS (Foreign Affairs Information System), 312 False intrusion detection, 489-490 False positives, 578 Falsifying messages, 422-423 Fame, attack motive, 402 Fault tolerance, networks, 377 Fault tree analysis (FTA), 168-169, 528 Faults active detection, 172-173 definition, 100 fixing, 99-101 passive detection, 172-173 Faux environment, 468-469

FBI al Qaeda computer, 24 breaking WEP, 467 Computer Crime and Security Survey, 582, 585 loss from attacks, 588 organized crime, 403-404 stolen laptops, 15 survey of cyberattacks, 102 value of cybersecurity, 578 Federal Educational Rights and Privacy Act, 610 Federal Trade Commission (FTC), 610 Federated databases, 363 Felten, Edward, 654 Fence register, 194-195 Fences, 193-194 Fermat's theorem, 729-730 Field checks, databases, 325 Fields, databases, 319 File lock channel, 152 File names, iishack problem, 425 File protection all-none, 215-216 group, 216-217 individual permissions, 217 per-object, 219 persistent permissions, 218 per-user, 219 SUID (set userid), 218-219 temporary acquired permissions, 218-219 Files access control. See Access control. directory access, 425-426 erasing deleted, 207, 271 Filters database reliability, 334 multilevel databases, 365 polarizing, 774-775 Final permutation, 739, 741 fingerd flaw, 136, 148 Fingerprint, operating system or applications. 406-407 Fingerprint authentication, 620-621. See also Biometrics. Fires, 557 Firewalls network encryption, 449-450 networks application proxy gateway, 478-480 authentication, 466 comparison of, 481-482 definition, 474

design, 474-475 guards, 480 limitations, 483-484 overview, 474 packet filtering gateway, 475-477 personal, 481 sample configuration, 482-484 stateful inspection, 477-478 types of, 475-480 rules set, 477 Firmware, legal issues, 660-661 First sale, 651 Flaws aliasing, 103 ambiguous access policies, 288 authentication, 103 boundary conditions, 103 definition, 101 domain errors, 103 exploitation examples, 289-290 identification, 103 incomplete mediation, 288-289 known vulnerabilities, 288-289 logic errors, 103 overview, 101-103 serialization, 103 time-of-check to time-of-use flaws, 288 types of, 103 typical flaws, 288-290 user interface vulnerability, 288 validation errors, 103 Floods, 556-557 Flow analysis, 158 FMEA (failure modes and effects analysis), 168-169, 528 Follett, Ken, 52 Footprints, satellite broadcast, 384-385 Foreign Affairs Information System (FAIS), 312 Forgery, 491, 640 Formal methods, 179 Formal verification, 292-294 Format failures, 423–424 Fortezza, 691. See also Keys (encryption), escrow. Frames, network, 388 Framing the issue, 590-591 Fraud Computer Fraud and Abuse Act, 683 ethical issues, 705-706 laws, 667 Free rides, 598

#### Free speech, and cryptography, 690-691 Freedom of Information Act, 684 Frequency probability, 534 Front end databases, 319 trusted, 360-361 FTA (fault tree analysis), 168-169, 528 FTC (Federal Trade Commission), 610 Full disclosure, 675-676 Full plaintext attacks, 65-66 Functional correctness, 244 Future earnings, adjusting, 575-576 Galois fields, 727-728 Gates, Bill on passwords, 229 on product quality, 678 Gateways application proxy, 478-480 packet filtering, 475-477 General knapsacks, 759-760 Genetic diversity, 165 Geosynchronous orbit, 384 German Green Book, 300-301 Gibson, Steve, 432 GISA (German Information Security Agency), 300-301 GLBA (Graham-Leach-Bliley Act), 610, 684 Goals of security, 10-12 Gottschalk v. Benson, 657-658 Government. See also specific governments. data mining, 624 e-mail, security policy example, 553 and privacy Council of Europe, 613 European Privacy Directive, 613 Icelandic DNA database, 351 principles and policies, 616-618 U.K. RIPA (Regulation of Investigatory Powers Act), 287 Graham-Denning security model, 257-259 Grandin, Temple, 401 Granularity, 193, 353 Greatest common divisor, 726 Group behavior, 591-592 Group file protection, 216-217 Guaranteed fair service, 267 Guards, 360-361, 480, 560 Guess function, 721

Guessing passwords, 415-416

827

Index

Hackers. See also Attackers; Crackers. versus crackers, 22 overview, 22 sting operation, 403 Hacking ethical. See Penetration testing. ethical issues, 707-710 Hactivism, attack motive, 403 Halting problem, 177, 261 Hard knapsacks, 763-764 Hardware. See also Cables; Networks. controls, 27 legal issues, 660 viruses, 132 Hardware-enforced protection, 191 Hash codes, 458. See also Hash function. Hash function, 493 Hazard analysis, 168-169, 528. See also Physical security. HAZOP (hazard and operability studies), 168-169, 528 Herald, New Zealand, 413 Heroes, organizational, 593 Heuristic intrusion detection, 485, 486-487 Hierarchical security policies, 248 Hierarchical structuring, 285-287 Hierarchies of complexity, 723 High-confidence software, 183 Highjackers, 632-633 HIPAA (Health Insurance Portability and Accountability Act), 610, 684-685 Hollywood e-mail theft, 20 Honeypots, 468-469 Hoo, Soo, 551 Host-based intrusion detection, 485 Hostile applets, 436, 499 Hosts, 379 Hot site backups, 565-566 HRU (Harrison-Ruzzo-Ullman) security model, 259-261 Huffman codes, 458 Human fallibility case study, 67 Hyppönen, Mikko, 22

#### IBM

history of DES, 69 Lucifer algorithm, 68–69 MVS/ESA operating system, 281 Processor Resources/System Manager (PR/SM), 282 U.S. government suit, 191

IC3 (Internet Crime Complaint Center), 584 Icelandic DNA database, 351 ICMP (Internet Control Message Protocol), 428 Identification versus authentication, 234-235 errors, 103 principles of trusted systems, 269 Identity (authentication), 619, 621-622 Identity (mathematical), 725 Identity theft, 618, 621 Ideology, attack motive, 403 IDS (intrusion detection system) anomaly based, 485 Common Intrusion Detection Framework, 484 definition, 484 false results, 489-490 goals for, 488-490 heuristic, 485, 486-487 host based, 485 misuse, 487 model based, 487 network based, 485 networks. See Networks, IDS. overview, 484-485 principles of trusted systems, 273 response to alarms, 489 signature based, 485, 486 state based, 487 statistical analysis, 486 stealth mode, 487-488 strengths and weaknesses, 490 types of, 485-488 IEEE (Institute for Electrical and Electronics Engineers) code of ethics, 710, 711 Standard 729, 100 IIS (Internet Information Server), 137-139, 140 iishack problem, 425 IKE (ISAKMP key exchange), 455-456 Images, signaling through. See Steganography. Imation Data Protection Survey, 584-585 Imbruglia, George, 28 Impedance, electrical, 410 Impersonation of login, 233-234 man-in-the-middle attack, 420 masquerade, 418-419

network threat, 415-420 phishing, 236, 419 session hijacking, 419-420 spoofing cryptographic protection, 462-463 interface illusions, 148-149 network vulnerability, 418 trusted path, 270-271 steganography, 159-160 trusted systems, 236 web bugs, 139-141, 631 Implementation flaws, 424 Incident response plans, 521-524 Incident response teams, 522-523 Incomplete mediation, 107-109, 288-289. See also Complete mediation. Independent testing, 172 Indirect attack, 343-350 Individual authentication, 619, 620 Inductance, 409 Industrial espionage, 402 Inference, database attacks combined results control, 348 concealing control, 347 controls for, 347-349 count attacks, 343-344 direct attack, 342-343 indirect attack, 343-350 limited response suppression, 347-348 linear system vulnerability, 346-347 mean attacks, 344 median attacks, 344-345 problem summary, 349-350 query analysis, 349 random data perturbation, 349 random sample control, 348-349 statistical inference attacks, 347 sum attacks, 343 suppression control, 347 tracker attacks, 345-346 Information. See also Data; Databases. anarchy, 676 collection, privacy issues, 606, 607 commerce, 665-666 depletion, 663 disclosure, privacy issues, 606 flow analysis, 158 hiding, 161-164 leaks, 16. See also Covert channels.

replication, 664 retention, privacy issues, 606 security, privacy issues, 606 usage, privacy issues, 606 Information officers, security responsibilities, 515 Information Security Breeches Survey (ISBS), 581, 585-586 Information Technology Security Evaluation Criteria (ITSEC), 300-303. 303-304 Informed consent, 607 Infrared networks, 383-384 Inherently hard problems, 724-725 Initial permutation, 739, 741 Inspection, code, 166 Installation testing, 170 Instances, 722 Institute for Electrical and Electronics Engineers (IEEE) code of ethics, 710, 711 Standard 729, 100 Intangible transfer, 665 Integrated viruses, 119 Integrated Vulnerability Assessments (IVAs), 530 Integration testing, 142, 170 Integrity data, 17, 19 data mining, 368-369 databases, 324-326, 329. See also Reliability. definition, 10 economic, 598 enforcement, 244 locks, 357-359, 359-360 multilevel databases, 354 overview, 11-12 \*-property, 256 threats, 680 Intellectual property, 650-651 Intelligence gathering, 406 Intent phase, 330 Intercepting sensitive information, 561-563 Interception, 7-8, 412, 636 Interceptors, 38 Interface illusions, 148-149 Internal networks, 395-396 Internal rate of return (IRR), 577 Internet, 552-553. See also Web sites. Internet Control Message Protocol (ICMP), 428 Internet Crime Complaint Center (IC3), 584

Internet Information Server (IIS), 137-139, 140 Internet protocol. See IP. Internet Scanner, 405 Internet Security Association Key Management Protocol (ISAKMP), 455 Internet Security Systems (ISS), 677 Internet worm, 134-137 Internets, 395-396 Interprocess communication, 267 Interruptions, 7-8 Intrinsic good, 697-698 Intruders, 38 Intrusion, characteristics, 4-5 Intrusion detection system (IDS). See IDS. Inverse initial permutation, 739, 741 Inverses, 725, 728-730 Invisible gif. See Web bugs. I/O operation, 277 IP addresses resolution, 425 shortage of, 393, 454 spoofing. See Spoofing. translation, 199, 202 IPSec (IP Security Protocol Suite), 454-456 IPv6, 454-456 Iris pattern authentication. See Biometrics. IRR (internal rate of return), 577 ISAKMP (Internet Security Association Key Management Protocol), 455 ISAKMP key exchange (IKE), 455-456 ISBS (Information Security Breeches Survey), 581, 585-586 ISO OSI (Open Systems Interconnection) model, 386-390 Isolation, 279-280 ISS (Internet Security Systems), 677 ITSEC (Information Technology Security Evaluation Criteria), 300-303, 303-304 Ivanov, Alexey, 403 IVAs (Integrated Vulnerability Assessments), 530 Jacobi function, 771-772

Japanese Naval code, 42 Java code, 435–437

#### Index

829

JetBlue airlines, 612-613 Job versus employee, 594 JVM (Java virtual machine), 435-437 Karger, Paul, 178 KDC (key distribution center), 213-214 Kennedy, Edward, 370 Kerberos access to protected objects, 213-214 network controls, 461-464 networks, 461-464 Kernel, 274 Kernelized design, 274-279 Key Online Banking, 452 Keyless ciphers, 40 Keyrings, e-mail, 495 Keys (encryption) clustering, 746 definition, 47 distribution, 62 encryption, 39 escrow, 691 exchange, 80-82 length, 743-745 management, 62 private, 39-40. See also AES; DES; Symmetric encryption. proliferation, 77 public. See also Asymmetric encryption; RSA. characteristics, 77 definition, 39 flow diagram, 40 key proliferation, 77 purpose of, 76 RSA (Rivest-Shamir-Adelman) encryption, 769 transformation, 736 Keystroke logging, 149, 632 Klein, Joe, 353 Knapsack problem, 719-720 Knapsacks as cryptographic algorithms, 761-763 decryption algorithm, 764-765 general, 759-760 hard, 763-764 Merkle-Hellman, 758-761, 766-767 and modular arithmetic, 761-763 simple, 760-761, 763 superincreasing, 760-761, 763-764 Kneed-to-know security policies, 246

KSOS, 191, 311

KVM, 191, 311 L0pht, 107, 405 L1-L6 assurance levels, 302 LAN (local area network), 394 Laptop computers, vulnerabilities, 14-15 Lattice security model, 253-254 Laws. See also Legal issues. California Breach Act, 686 CAN SPAM Act, 685-686 civil, 667 contract, 668-669 Council of Europe Agreement on Cybercrime, 687 criminal, 667 versus ethics, 692-694 E.U. Data Protection Act, 687 fraud, 667 GLBA (Graham-Leach-Bliley Act), 684 HIPAA (Health Insurance Portability and Accountability Act), 684-685 information-related database protection, 666 depletion, 663 electronic commerce, 666-667 electronic publishing, 666 information commerce, 665-666 intangible transfer, 665 marginal cost, 664 as object, 663-665 replication, 664 time-dependent value, 664-665 protecting computer artifacts, 669 RIPA (Regulation of Investigatory Powers Act), 287 statutes, definition, 667 statutes, examples, 683-686 tort, 667-668 U.S. Computer Fraud and Abuse Act, 683 U.S. Economic Espionage Act, 683 U.S. Electronic Communications Privacy Act, 684 U.S. Electronic Funds Transfer Act, 683 U.S. Freedom of Information Act, 684 U.S. Privacy Act, 684 USA Patriot Act, 685 Layered defense, 29 Layered trust, 283-287

Layering networks, 389 Leaking access rights, 261 information, 16. See also Covert channels. Least common mechanism, 266 Least privilege, 265 Legal control. See Laws; Legal issues. Legal issues. See also Ethical issues; Laws. computer crime California Breach Act, 686 CAN SPAM Act. 685-686 Computer Fraud and Abuse Act, 683 computer terminology and the law, 681 confidentiality threats, 680 Council of Europe Agreement on Cybercrime, 687 cryptography, 688, 688-692 defining, 681-682 Economic Espionage Act, 683 Electronic Communications Privacy Act, 684 Electronic Funds Transfer Act, 683 E.U. Data Protection Act, 687 Freedom of Information Act, 684 GLBA (Graham-Leach-Bliley Act), 684 HIPAA (Health Insurance Portability and Accountability Act), 684-685 integrity threats, 680 international dimensions, 686-688 overview, 679 Patriot Act, 685 Privacy Act, 684 prosecuting, 682-683 restricted content, 687-688 rules of evidence, 680 rules of property, 679-680 scope limitations, 688-689 statutes, examples, 683-686 value of data, 681 cryptography, 688-692 overview, 647-649 program and data protection computer objects, 659-662 copyright, 649-655, 660 documentation protection, 662 domain names, 662 firmware, 660-661

hardware, 660 object code software, 661 patents, 655-658, 660 reverse engineering, 658-659 source code software, 661-662 trade secrets, 658-659, 660 trademark, 662 URLs, 662 web content, 662 rights of employees and employers copyright ownership, 671 employee contracts, 672 licensed software, 671 patent ownership, 670-671 product ownership, 670-672 trade secrets, 672 work for hire, 671 software failure full disclosure, 675-676 overview, 673 quality demands, 674-675 quality software, 678-679 refunds, 674 reporting flaws, 675-679 selling correct software, 673-674 user interests, 676 vendor interests, 676 warranty of cyberworthiness, 675 Legislation. See Laws. Levy, Elias, 148-149 Lewis, John, 370 Library viruses, 124 Licensed software, 671 Limited privilege, 244 Limited response suppression, 347-348 Linear system vulnerability, 346-347 Link encryption, 445-446 Links, network, 379 Linux, 295 Litchfield, David, 676 Lloyd's Bank, 452 Local area network (LAN), 394 Local name space, 211 Locks access control, 560 integrity, 357-359, 359-360 sensitivity, 359 "spray paint," 357-359 Logic bombs, 16, 116 Logic errors, 103 Logical separation, 191, 279-280 Logs audit, 272-273 database changes, 326

database transactions, 324 reduction, 272-273 Loose versus tight organizational control, 595 Loose-lipped system, 222 Lower bound, 254 Lucifer algorithm, 68-69 Lynn, Michael, 677 MAC (mandatory access control), 269-270 MAC (Media Access Control) address, 388 Mafia boss case study, 45 Mafiaboy, 404 Magnetic remanence, 270 Malformed packets, 423-424 Malicious code. See also Nonmalicious errors; Programs, security; Viruses; Worms. agents, 114 history of, 113-114 implementation time, 116 interface illusions, 148-149 keystroke logging, 149 logic bombs, 116 man-in-the-middle attacks, 149 potential for harm, 113 privilege escalation, 147-148 rabbits, 116 rootkit revealers, 146 rootkits, 145-147 Sony XCP (extended copy protection) rootkit, 145-147 spoofing, 148-149 threat assessment, 125 time bombs, 116 timing attacks, 150 Trojan horses, 116 types of, 114, 116-117 worms, 116 zero day exploits, 116 Malware. See Malicious code. MAN (metropolitan area network), 395 Managers, security responsibilities, 515 Mandatory access control (MAC), 269 - 270Man-in-the-middle attacks, 149, 420. See also Impersonation; Masquerade; Spoofing. Mapping controls to vulnerabilities, 537, 539 Marginal cost, 664

Marketability, evaluating, 303 Marks, Leo, 48 MARS algorithm, 748 Masquerade, 418-419. See also Manin-the-middle; Spoofing. Mathematics of cryptography. See Cryptography, mathematics of. MD4 hash function, 80 MD5 hash function, 80 Mean attacks, 344 Media, network, 382-385 Media Access Control (MAC) address, 388 Median attacks, 344-345 Mediation complete, 265-266, 270 incomplete, 107-109, 288-289 Memory and address protection base/bounds registers, 195-196 context switch, 195-196 fences, 193-194 page frames, 202 paging, 202-203, 203-204 Palladium (protect memory project), 238 principles of trusted systems, 266, 277 relocation, 194-195 relocation factor, 195 segment address table, 199 segmentation, 199-202, 203-204 tagged architecture, 196-199 Memory-resident viruses, 123-124 Merkle-Hellman knapsacks, 758-761, 766-767 Message confidentiality, 420-422 Message digests. See Cryptographic checksum. Message integrity, 422-423 Method, opportunity, motive (MOM), 8-9 Methods of attack. See Attacks, methods. defense. See Controls: Defense methods Metropolitan area network (MAN), 395 MIC (message integrity check), 493 Microcontrollers, automobile control systems, 3 Microcontrollers in automobiles, 3 Microsoft on career criminals, 22 on full disclosure, 675-676

#### passport, 232 on passwords, 229 patching flaws, 676 on product quality, 678 single sign-on, 232 Microsoft Redaction Tool, 271 Microsoft Word, deleting text, 271 Microwave networks description, 383 eavesdropping, 410-411 wiretapping, 410-411 Military security policies, 246-248 Mining, data. See Data mining. Misdelivering messages, 420-421 Misuse intrusion detection, 487 Mitnick, Kevin, 401 Mix column, 752-753 Mixmaster remailers, 637-638 Mixter, 401 Mobile agents, 444 Mobile code, 433 Model-based intrusion detection, 487 Modeling security economics credibility, 592 decision making, 590-592 framing the issue, 590-591 group behavior, 591-592 overview, 589 role of organizational culture, 592-597 transferring models, 589-590 trust as economic issue, 592 Models, security. See Security models. Modular arithmetic, 43, 726-728 Modularity of code, 161-164 MOM (method, opportunity, motive), 8-9 Money, attack motive, 402 Monitoring e-mail, 637 privacy, 606 Monitors, 190, 334–335 Monoalphabetic cipher, 44 Moore's Law, 43 Morals. See Ethical issues. Morris, Robert, Jr., 134-137, 400 Morris, Robert, Sr., 136 Motives for attacks, 399-404 MP3.com, 655 Multics, 178, 191, 311 Multifactor authentication, 222 Multilevel databases. See Databases, multilevel. Multilevel security, 253-257 Multiple identities, 614-616

831

Index

Multiple virtual memory spaces, 281 Multiplexed signals, 410 Multiprogrammed operating systems, 190 Mundie, Craig, 296, 676 Mutual authentication, 463 Mutual suspicion, 164 Napster, 655 National Institute of Standards and Technology (NIST), 72 National Research Council (NRC), 691 National Security Agency (NSA), 69, 181, 742-743 Natural disasters, 556-558 NBS (National Bureau of Standards), 68-69,72 NCSC (National Computer Security Center), 297, 304 Negative result disclosure, 339 Nessus, 405 Net present value, 574-577 netcat scanner, 405 Network interface cards (NICs), 387-388 Network-based intrusion detection, 485 Networked backups, 565 Networks address shortage, 393, 454 amplifiers, 383 analog communication, 382 angle of dispersion, 384-385 boundaries, 381-382 cables coaxial, 382 eavesdropping, 409-410 Ethernet, 383 impedance, 410 inductance, 409 networking, 382-383 UTP (unshielded twisted pair), 382 wiretapping, 409-410 CAN (campus area network), 395 clients, 378-379 coaxial cable, 382 communication mode, 382 control, 381-382 datagrams, 391 diagram of, 380 digital communication, 382 domain names, 393 environment of use, 379, 381

Ethernet cable, 383 fault tolerance, 377 firewalls application proxy gateway, 478-480 comparison of, 481-482 definition, 474 design, 474-475 guards, 480 limitations, 483-484 overview, 474 packet filtering gateway, 475-477 personal, 481 sample configuration, 482-484 stateful inspection, 477-478 types of, 475-480 footprints, 384-385 frames, 388 geosynchronous orbit, 384 hosts, 379 IDS (intrusion detection system) anomaly based, 485 definition, 484 false results, 489-490 goals for, 488-490 heuristic, 485, 486-487 host based, 485 misuse, 487 model based, 487 network based, 485 overview, 484-485 response to alarms, 489 signature based, 485, 486 state based, 487 statistical analysis, 486 stealth mode, 487-488 strengths and weaknesses, 490 types of, 485-488 infrared, 383-384 the Internet, 395-396 internets, 395-396 LAN (local area network), 394 layering, 389 links, 379 MAC (Media Access Control) address, 388 MAN (metropolitan area network), 395 media, 382-385 microwave, 383 NICs (network interface cards), 387-388 nodes, 379 opaqueness, 379

optical fiber, 383 OSI (Open Systems Interconnection) model, 386-390 overview, 378-379 ownership, 381-382 packets, 387, 391 peers, 386 port numbers, 391 protocol stack, 385 protocols, 385-393 repeaters, 383 resilience, 377 routers, 387 routing concepts, 393 satellite, 384-385 secure e-mail confidentiality, 492-493 designs, 492-494 encryption, 493-494 keyrings, 495 MIC (message integrity check), 493 PGP (Pretty Good Privacy), 494-496 requirements, 491 ring of trust, 495 sample systems, 494-496 S/MIME (Secure MIME), 496 solutions, 491 threats, 491 servers, 378-379 sessions, 429 shape, 381-382 single point of failure, 377 size, 381-382 SYN\_RECV connections, 429 TCP protocols, 391-392 TCP/IP protocol, 391-393 top-level domain, 393 topography, 381-382 types of, 394-396 UDP (user datagram protocol), 391-392 UTP (unshielded twisted pair) cable, 382 WAN (wide area network), 395 wireless, 383 workstations, 379 Networks, controls ACLs (access control lists), 464-466 alarms, 468 alerts, 468 architecture, 442-443

challenge-response systems, 460 content integrity, 457-459 cryptographic checksum, 458-459 design, 441-442 Digital distributed authentication, 460-461 encryption AH (authentication header), 455 certificate authorities, 451 comparison of methods, 447-449 e-mail, 457 encrypted tunnels, 449-450 end-to-end, 446-447 ESP (encapsulated security payload), 455 firewalls, 449-450 IKE (ISAKMP key exchange), 455-456 ISAKMP (Internet Security Association Key Management Protocol), 455 issues, 453 link, 445-446 overview, 444-445 PKI (public key infrastructure), 450-453 security associations, 454-455 signed code, 456-457 SPI (security parameter index), 455 SSH (secure shell), 453 SSL (Secure Sockets Layer), 453-454 TLS (transport layer security), 453-454 tunnels, 449-450 VPNs (virtual private networks), 449-450 error correcting codes, 458 error detection, 458 even parity, 458 failover mode, 443 failure tolerance, 443-444 firewalls, 466 hash codes, 458 honeypots, 468-469 Huffman codes, 458 implementation, 441-442 intrusion detection, 468 Kerberos, 461-464 mobile agents, 444 odd parity, 458 one-time password, 459-460 onion routing, 470 parity check, 458

password tokens, 459-460 redundancy, 443 router access controls, 464-466 segmentation, 442-443 single points of failure, 443-444 SSID (Service Set Identifier), 466-467 strong authentication, 459-464 summary of, 470-474 threat analysis, 440-441 tickets, 461 TKIP (Temporal Key Integrity Program), 467–468 traffic flow security, 469-470 WEP (wired equivalent privacy), 467 wireless security, 466-468 WPA (WiFi Protected Access), 467-468 Networks, threats active code, 433, 435-437 active wiretapping, 409 ActiveX controls, 435-437 anonymity, 397 application code errors, 426 ASP (active server pages), 435 attackers, 399-404 authentication vulnerabilities avoidance, 416-417 eavesdropping, 416 guessing passwords, 415–416 man-in-the-middle attack, 420 masquerade, 418-419 nonexistent authentication, 417 phishing, 419 session hijacking, 419-420 spoofing, 418. See also Man-inthe-middle; Masquerade. trusted authentication, 418 well-known authentication, 417-418 wiretapping, 416 automatic exec by file type, 437 botnets, 437-438 bots, 437-438 broadcast mode, 428-429 buffer overflow, 425 bulletin boards, 407 cable eavesdropping, 409-410 impedance, 410 inductance, 409 wiretapping, 409-410 challenge motive, 400 chats, 407

#### Index

833

complex attacks, 438 connection flooding, 427-428 cookies, 434 cyberterrorism, 403 DDoS (distributed denial of service), 431-433 defacing web sites, 424-425 distributed authentication, 398 DNS attacks, 431 DNS cache poisoning, 431 documentation availability, 407 DoS (denial of service), 427-431 dot-dot-slash directory travel, 425-426 dumpster diving, 406-407 eavesdropping, 408-414 echo chargen, 428 escape-character attack, 434-435 espionage, 402 exposing messages, 421-422 falsifying messages, 422-423 fame motive, 402 format failures, 423-424 hactivism, 403 hostile applets, 436 ICMP (Internet Control Message Protocol), 428 ideological motive, 403 iishack problem, 425 impersonation, 415-420 implementation flaws, 424 intelligence gathering, 406 Java code, 435-437 JVM (Java virtual machine), 435-437 malformed packets, 423-424 message confidentiality, 420-422 message integrity, 422-423 microwave, 410-411 misdelivering messages, 420-421 in mobile code, 433 money motive, 402 motives for attacks, 399-404 multiple points of attack, 397 multiplexed signals, 410 noise, 423 optical fiber, 411 organized crime, 403 packet sniffers, 409-410 passive wiretapping, 409 ping of death, 428 port scans, 404-405 protocol failures, 424 protocol flaws, 414 reconnaissance, 404-408

Networks, threats (continued) replaying old messages, 422-423 RFC (Request For Comment), 414 rogue access points, 408 sandbox, 435 satellite, 411 script kiddies, 438 scripts, 434-435 server-side includes, 427 sharing, 397 smurf attack, 428-429 social engineering, 405-406 SYN flood, 429 system complexity, 397 system fingerprinting, 406-407 teardrop attacks, 430 traffic flow analysis, 422 traffic redirection, 430 transmission failure, 427 unknown path, 399 unknown perimeter, 398-399 vulnerabilities, 397-399 vulnerabilities, summary of, 438 war driving, 408 web site vulnerabilities, 424-427 wireless eavesdropping, 411-413 interception, 412 rogue access points, 408 theft of service, 408, 412 vulnerabilities, 413 war driving, 408 wiretapping, 411-413 wiretapping, 408-414 zombies, 431-433 New Zealand Herald, 413 NICs (network interface cards), 387-388 NIST (National Institute of Standards and Technology), 72 nmap scanner, 405 Nodes, network, 379 Noise, in communications, 423 Nondeterminism, 721 Nondeterministic Turing machines, 721 Nonexistent authentication, 417 Nonhierarchical security policies, 248 Nonmalicious errors. See also Malicious code; Programs, security. buffer overflows, 104-107 causes of failures, 112 combined flaws, 111 incomplete mediation, 107-109 synchronization, 109-111 time-of-check to time-of-use errors, 109-111

Normative versus pragmatic organizations, 595 NP class, 721 NP-complete problems, 719-724 NRC (National Research Council), 691 NSA (National Security Agency), 69, 181, 742-743 Nuclear weapons, tracking, 140 Nucleus. See Kernel. Number of iterations, 743 Number theory, 78, 724 Object code, legal issues, 661. See also Copyright. Objects, digital allocation, 266-267 copying, 654-655 copyright, 653-655 information as, 663-665 legal issues, 659-662 patents, 657-658 protected. See Protected objects. reusing, 270 OCTAVE methodology, 511 Odd parity, 458 Odlyzko, Andrew, 597 Offers, web privacy, 629 Offsite backups, 564 One-by-one gif. See Web bugs. One-time execution viruses, 122 One-time pads, 50-54 One-time passwords, 231-232, 459-460 One-way functions, 79 Onion routing, 470 Online banking, 452 Online environment, 626-627 Online profiling, 631 Opaqueness, of network, 379 Opcodes, 143 Open design, 265 Open source, 295-296 Open Systems Interconnection (OSI) model, 386-390 Open versus closed organizations, 595 Operating system data protection, 267-268 Operating system protection features, 329-330 Operating system security. See also Programs, security; Trusted systems. cryptographic separation, 192 executives, 189-190 file protection

all-none, 215-216 group, 216-217 individual permissions, 217 per-object, 219 persistent permissions, 218 per-user, 219 SUID (set userid), 218-219 temporary acquired permissions, 218-219 granularity, 193 hardware-enforced protection, 191 history of, 189-190 levels of protection, 192 logical separation, 191 memory and address protection base/bounds registers, 195-196 context switch, 195-196 fences, 193-194 page frames, 202 paging, 202-203, 203-204 relocation, 194-195 relocation factor, 195 segment address table, 199 segmentation, 199-202, 203-204 selective protection. See Tagged architecture. tagged architecture, 196-199 monitors, 190 multiprogrammed operating systems, 190 physical separation, 191 protected objects, accessing AS (authentication server), 213-214 access control matrix, 210-211 ACLs (access control lists), 208-210 capability, 210-213 directories, 205-208 domains, 211 erasing deleted files, 207 KDC (key distribution center), 213-214 Kerberos, 213-214 local name space, 211 procedure-oriented, 214-215 protection goals, 205 pseudonyms, 207-208 revocation of access, 206-207 role-based, 215 single sign-on, 214 TGS (ticket-granting server), 213-214 types of, 204-205 wild cards, 208-210 protection methods, 189-193

separation, 190-193 system functions, 188-189 temporal separation, 191 user authentication additional authentication information, 221-222 biometrics, 219-220, 234-236 challenge-response system, 231-232, 233-234 cookies, 236 flaws, 233-234 versus identification, 234-235 impersonating trusted systems, 236 impersonation of login, 233-234 multifactor authentication, 222 one-time passwords, 231-232 overview, 219 password attacks, 222-229 password selection criteria, 229-231 passwords as authenticators, 221 phishing, 236 process description, 232-234 single sign-on, 232 two-factor authentication, 222 Opportunity cost, 576 Optical fiber networks description, 383 eavesdropping, 411 wiretapping, 411 Oracle, estimating security costs, 578 Oracles, 721 Orange Book. See TCSEC. Organizational culture cultural practices, 593-594 cultural values, 594 dimensions of, 595 employee versus job, 594 heroes, 593 loose versus tight control, 595 normative versus pragmatic, 595 open versus closed, 595 parochial versus professional, 595 process versus results, 594 rituals, 593 role of organizational culture, 592-597 security choices, examples, 596 symbols, 592 Organized crime, 403 Originality of work, 651 OSI (Open Systems Interconnection) model, 386-390 Overlapping controls, 29 Overwriting magnetic data, 562

Owners, 548 Ownership of data, 608 networks, 381–382 programs, 702–704 web sites, 628–629 Ozment, Andy, 598

P class, 721 Packet filtering gateways, 475-477 Packet sniffers, 409-410 Packets, network, 387, 391 Page address translation, 202 Page frames, 202 Page size, 202 Page translation table, 203-204 Paged segmentation, 203-204 Paging, 202-203, 203-204 Palladium (protect memory project), 238 Parallel attack, 744-745 Parity check, 458 Parker, Donn, 401 Parochial versus professional organizations, 595 Partial ordering, 254 Partial plaintext attacks, 65-66 Partitioning multilevel databases, 356 Passenger Name Record (PNR), 615 Passive fault detection, 172-173 Passive wiretapping, 409 Passport, 232 Pass-through problem, 326 Password attacks 12-step process, 226 brute force, 223 encrypted password file, 227-228 exhaustive, 223 guessing, 464 indiscreet users, 228-229 plaintext password list, 226 probability, 224 salt extension, 228 trial and error, 222 weak passwords, 224-227 Passwords as authenticators, 221 frequency of change, 230-231 guessing, 415-416 with Kerberos 462 Microsoft, 229 mnemonic qualities, 230 network tokens, 459-460 one-time, 231-232 selection criteria, 229-231 Patents

#### Index

835

for computer objects, 657-658 definition, 655 Diamond v. Bradley, 658 Diamond v. Diehr, 658 Gottschalk v. Benson, 657-658 infringement, 657 legal issues, 655-658, 660 ownership, 670-671 registering, 656-657 requirements of novelty, 656 Path, trusted. See Trusted path. Patriot Act, 685 Patterns cryptographic permutations, 56-57 database reliability, 334 virus signatures, 125-127 Payment schemes, web privacy, 627 Payments online, web privacy, 627 P-boxes, 739, 741 PDF, deleting text, 271 Peer reviews, 165-168 Peers, network, 386 Penetrate-and-patch technique, 100 Penetration testing, 172, 177, 291 Performance testing, 170 Permission based principles of trusted systems, 266 Permissions. See also Privilege. individual, 217 persistent, 218 temporary acquired, 218-219 Permutation cycle, 734 Permutations columnar transpositions, 55-58 combined approaches, 58 definition, 55 digram analysis, 57-58 digrams, 56-57 encipherment/decipherment complexity, 56 patterns, 56-57 product ciphers, 58 substitution ciphers, 46-47 symmetric encryption, 730 trigrams, 56-57 types, 736 Permuted choices, 733 Per-object file protection, 219 Per-session cookies, 434 Persistent cookies, 434 Personal computer users, security responsibilities, 514 Personal firewall, 481 Personal identification number (PIN), 219

Personnel staff members, security responsibilities, 516 Per-subject protection, 208-210 Per-user file protection, 219 PGP (Pretty Good Privacy), 494-496 Phishing, 236, 419. See also Impersonation. Photon reception, 775 Photons, cryptography with, 775-776 Physical controls, 27 Physical security backing up data, 563-566 cold site backups, 565 complete backups, 564 computer screen emanations, 562-563 contingency planning, 563-566 definition, 556 degaussing magnetic data, 562 "dirty" power, 558 fires, 557 floods, 556-557 guards, 560 hot site backups, 565-566 intercepting sensitive information, 561-563 locks, 560 natural disasters, 556-558 networked backups, 565 offsite backups, 564 overwriting magnetic data, 562 power loss, 558 revolving backups, 564 selective backups, 564 shell backups, 565 shredding paper data, 562 smart cards, 560 surge suppressors, 558-559 Tempest program, 562-563 theft prevention, 559-561 unauthorized access, 559 UPS (uninterruptible power supply), 558 vandalism, 559-561 Physical separation, 191, 279-280 PIN (personal identification number), 219 Ping of death, 428 Ping protocol, 438 Piracy, 651 Pixel tags. See Web bugs. PKI (public key infrastructure), 450-453 Plaintext chosen plaintext attacks, 66

ciphertext only attacks, 65 definition, 39 full plaintext attacks, 65-66 partial plaintext attacks, 65-66 password list attacks, 226 probable plaintext attacks, 66 Planning, security. See Risk analysis; Security plan. PNR (Passenger Name Record), 615 Poem codes, 48 Polarizing filters, 774-775 Policies. See also Principles; Security policies; Standards. economic, 597 privacy. See Privacy, principles and policies. security. See Security policies. Polyinstantiation, 355 Polymorphism, viruses, 127-128 Port numbers, 391 Port scans, 404-405 Power, electrical, 558-559 Power, Richard, 9 Power off, virus defense, 132 Pragmatic versus normative organizations, 595 Precision versus security, 339-341 Prediction, of risk. See Risk analysis. Pretty Good Privacy (PGP), 494-496 Prevention. See Controls; Defense methods. Prime numbers, 725 Primitive operations, 259-260 Principles. See also Policies; Standards. economic, 597 privacy. See Privacy, principles and policies. security adequate protection, 17 easiest penetration, 5 effectiveness, 28 weakest link, 29-30 trusted systems. See Trusted systems, design principles. Privacy. See also Confidentiality. access control, 606 affected subject, 605-606 aspects of, 604-606 authentication anonymized records, 622-623 attributes, 620 identity, 619, 621-622 individual, 619, 620 meaning of, 619-620

overview, 619 case study, 615 computer-related problems, 606-608 controlled disclosure, 604 data mining aggregation of data, 625-626 correlation of data, 624-625 data perturbation, 624-626 government, 624 preserving privacy, 624-626 sensitive data, 368 dimensions of privacy, 606-608 e-mail access control, 636 anonymous, 637-638 interception, 636 mixmaster remailers, 637-638 monitoring, 637 overview, 635 remailers, 637-638 simple remailers, 637 spamming, 638 spoofing, 638 transmitting, 636 emerging technologies consumer products, 639-640 electronic voting, 641-642 overview, 638-639 privacy issues, 640-641 RFID (radio frequency identification), 640 security issues, 640-641 Skype, 642 VoIP (Voice over IP), 642 government and Council of Europe, 613 European Privacy Directive, 613 Icelandic DNA database, 351 principles and policies, 616-618 U.K. RIPA (Regulation of Investigatory Powers Act), 287 history of, 603 information collection, 606, 607 information disclosure, 606 information retention, 606 information security, 606 information usage, 606 informed consent, 607 loss of control, 607-608 monitoring, 606 ownership of data, 608 policy changes, 607 principles and policies

access control, 618 anonymity, 614 audit trails, 618 authentication, 617 Convention 108, 613 COPPA (Children's Online Privacy Protection Act), 610 Council of Europe, 613 data access risks, 617 data anonymization, 618 data left in place, 618 data minimization, 617-618 deceptive practices, 612-613 defense methods, 617-618 Directive 95/46/EC, 613 e-Government Act of 2000, 611 European Privacy Directive, 613 Fair Credit Reporting Act, 610 fair information, 609-610 Fair Information Policies, 613-614 Federal Educational Rights and Privacy Act, 610 FTC (Federal Trade Commission), 610 GLBA (Graham-Leach-Bliley Act), 610 government policies, 616-618 HIPAA (Health Insurance Portability and Accountability Act), 610 identity theft, 618 multiple identities, 614-616 non-U.S., 613-614 Privacy Act (5 USC 552a), 610 protecting stored data, 609-610 pseudonymity, 616 quality, 618 restricted usage, 618 training, 618 U.S. laws, 610-611 Ware committee report, 610 web site controls, commercial, 612 - 613web site controls, government, 611 rights, ethical issues, 700-701 RIPA (Regulation of Investigatory Powers Act), 287 sensitive data, 604-605 on the web advertising, 628-629 adware, 633-634 contests, 629 cookies, 629-631

credit card payments, 627 drive-by installation, 634 highjackers, 632-633 keystroke loggers, 632 offers, 629 online environment, 626-627 online profiling, 631 payment schemes, 627 payments online, 627 precautions, 629-631 registration, 628 shopping, 634-635 site ownership, 628-629 spyware, 632-634 third-party ads, 628-629 third-party cookies, 630-631 web bugs, 631 Privacy Act, 610, 684 Privacy-preserving data mining, 624-626 Private key encryption, 39-40. See also AES; DES; Symmetric encryption. Privilege. See also Permissions. escalation, 147-148 limited, 244 Probability, 534 Probability password attacks, 224 Probable plaintext attacks, 66 Probable value disclosure, 339 Problems, cryptographic, 722-723 Procedure-oriented access control, 214-215 Process activation, 276 Process versus results organizations, 594 Product cipher, DES, 733 Product ciphers, 58 Product ownership, 670-672 Professional versus parochial organizations, 595 Profile, of attackers, 401 Programs definition, 98. See also Application; Code; Software. protection legal issues computer objects, 659-662 copyright, 649-655, 660 documentation protection, 662 domain names, 662 firmware, 660-661 hardware, 660 object code software, 661 patents, 655-658, 660 reverse engineering, 658-659

#### source code software, 661-662 trade secrets, 658-659, 660 trademark, 662 URLs, 662 web content, 662 Programs, security. See also Operating system security; Trusted systems. controls. See Controls, software development. cyber attacks, 101-102 errors, 100 failures, 100 faults, 100 fixing faults, 99-101 flaws aliasing, 103 authentication, 103 boundary conditions, 103 definition, 101 domain errors, 103 identification, 103 logic errors, 103 overview, 101-103 serialization, 103 types of, 103 validation errors, 103 IEEE Standard 729, 100 intentional incidents. See Cyber attacks. malicious code. See also Attacks, methods; Trapdoors; Viruses. agents, 114 back doors. See Trapdoors. history of, 113-114 implementation time, 116 interface illusions, 148-149 keystroke logging, 149 leaking information. See Covert channels. logic bombs, 116 man-in-the-middle attacks, 149 potential for harm, 113 privilege escalation, 147-148 rabbits, 116 rootkit revealers, 146 rootkits, 145-147 Sony XCP (extended copy protection) rootkit, 145-147 spoofing, 148-149 threat assessment, 125 time bombs, 116 timing attacks, 150 Trojan horses, 116 types of, 114, 116-117

#### 837

Index

Programs, security (continued) malicious code (continued) worms, 116 zero day exploits, 116 nonmalicious errors buffer overflows, 104-107 causes of failures, 112 combined flaws, 111 incomplete mediation, 107-109 synchronization, 109-111 time-of-check to time-of-use errors, 109-111 overview, 99 penetrate-and-patch technique, 100 unexpected behavior, 101-103 Project leaders, security responsibilities, 514 Proliferation of keys, 77 Proof of program correctness, 177-178 Propagation of errors, 64 \*-property (star property), 255–256 Proprietary resources, ethical issues, 704 Prosecuting computer crime, 682-683 Protected objects, accessing AS (authentication server), 213-214 access control matrix, 210-211 ACLs (access control lists), 208-210 capability, 210-213 directories, 205-208 domains, 211 erasing deleted files, 207 KDC (key distribution center), 213-214 Kerberos, 213-214 local name space, 211 procedure-oriented, 214-215 protection goals, 205 pseudonyms, 207-208 revocation of access, 206-207 role-based, 215 single sign-on, 214 TGS (ticket-granting server), 213-214 types of, 204-205 wild cards, 208-210 Protecting stored data, 609-610 Protection. See Controls; Defense methods. Protection profiles, 305 Protection system commands, 258 Protection systems, 260

Protocols destination unreachable, 438 echo, 438 encryption, 26 failures, 424 flaws, 414 networking, 385-393 ping, 438 SMTP (simple mail transport protocol), 392 SNMP (simple network management protocol), 392 source quench, 438 stack, 385 TCP/IP, 391-393 UDP (user datagram protocol), 391-392 Provenzano, Bernardo, 45 Proxies, 478-480 Proxy firewall, 482-483 PR/SM. See IBM, Processor Resources/System Manager. Pseudonymity, 616 Pseudonyms, 207-208 PSOS (Provably Secure Operating System), 284-287 Public domain, 650 Public key encryption. See also Asymmetric encryption; RSA. characteristics, 77 definition, 39 flow diagram, 40 key proliferation, 77 purpose of, 76 Public key infrastructure (PKI), 450-453

#### (

Q0-Q7 quality levels, 301 Quality demands, 674-675 privacy principles and policies, 618 software, 678-679 Quantifying security value accurate data, 581 attack sources, 588 attack types, 587 comparability of categories, 587 consistent data, 581 cost of U.K. security incidents, 586 economic impact, 580, 586, 588 ISBS (Information Security Breeches Survey), 581, 585-586 justification data, 580-581

overview, 578-580 reliable data, 581 representative data, 586 respondent types, 587 security practices, 581, 585-586 timelines, 581 Quantum cryptography cryptography with photons, 775-776 implementation, 776-778 overview, 774 photon reception, 775 polarizing filters, 774-775 quantum physics, 774-775 Quantum physics, 774-775 Queries database, 321-323 Query analysis, database inference, 349

Rabbits, 116 Radio frequency identification (RFID), 640 RAND Corporation, 184, 609 Random number sequences, 50 Random sample control, 348-349 Ranum, Marcus, 296 RC2 cipher, 754-755 RC4 cipher, 755-756 RC5 cipher, 756 RC6 algorithm, 749 Read-only files, viruses, 131 Realism, 550 Rearrangement. See Permutation. Recipients, 38 Reconnaissance, 404-408 Records, database, 319, 321-323 Recovery from backup, 332 Redaction Tool, 271 Redundancy database reliability, 332 multilevel databases, 355 networks, 443 process comparison, 173 Reference monitor, 275 Refunds, 674 Registration copyright, 652 patents, 656-657 web privacy, 628 Regression testing, 170 Regulation, economics, 598-599 Regulation of Investigatory Powers Act (RIPA), 287 Relational operators, 254 Relations, database, 321

Relatively prime values, 762 Release proliferation, 327 Reliability databases. See also Integrity. commit flag, 330 committing updates, 330 concurrency, 333 consistency, 332, 333 correction codes, 332 data form checks, 334 definition, 329 error detection, 332 filters, 334 intent phase, 330 monitors, 334-335 operating system protection features, 329-330 patterns, 334 recovery from backup, 332 redundancy, 332 shadow fields, 332 shadow values, 331-332 state constraints, 334-335 transition constraints, 335 two-phase update, 330-332 Religion, and ethics, 694 Relocation, 194-195 Relocation factor, 195 Remailers, 637-638 Remanence, magnetic, 270 Repeaters, network, 383 Replay attack, 422-423 Reporting computer crime, 21 program flaws, 675-679 Reprocessing used data items, 18 Request For Comment (RFC), 414 Requirements checking, 295 Requirements of novelty, 656 Resident viruses, 114-116 Resilience, network, 377 Resorla, Eric, 598 Respondent types, 587 Response to alarms, 489 CERT (Computer Emergency Response Team), 432 intrusion detection, 489 limited response suppression, 347-348 plans, 521-524 teams, 522-523 Responsibility for security, 514-516 Restricted content, 687-688 Restricted usage, 618

Results versus process organizations, 594 Retina pattern authentication. See Biometrics. Return on investment (ROI), 577-578 Reverse engineering, 658-659 Reviews, design and code, 295 Revocation of access, 206-207 Revolving backups, 564 RFC (Request For Comment), 414 RFID (radio frequency identification), 640 .rhosts file, 417-418 Right, versus wrong. See Ethics. Rights of employees and employers copyright ownership, 671 employee contracts, 672 licensed software, 671 patent ownership, 670-671 product ownership, 670-672 trade secrets, 672 work for hire, 671 Rijmen, Vincent, 72 Rijndael algorithm, 73, 749. See also AES. Ring of trust, 495 RIPA (Regulation of Investigatory Powers Act), 287 Risk analysis. See also Security plan. classical probability, 534 Delphi approach, 533-534 FMEA (failure modes and effects analysis), 528 frequency probability, 534 FTA (fault tree analysis), 528 hazard analysis techniques, 528 HAZOP (hazard and operability studies), 528 IVAs (Integrated Vulnerability Assessments), 530 nature of risk, 525 probability, 534 pros and cons, 544-547 steps involved in alternative steps, 526 asset identification, 526-527 control selection, 536-542 cost/benefit analysis, 544 expected loss computations, 535-536 exploitation estimation, 531-535 savings projections, 542-544 vulnerability identification, 527-531 subjective probability, 534

## Index 839 VAM (Vulnerability Assessment

and Mitigation), 527 Risks definition, 524 exposure, 524 impact, 524 leverage, 525 nature of, 525 prediction, 173-174. See also Risk analysis. Rituals, organizational, 593 Rivest, Ron, 754 Rivest-Shamir-Adelman (RSA) encryption. See RSA. .rlogin file, 417-418 Rochefort, Joseph, 42 Rogue access points, 408 Rogue programs. See Malicious code. ROI (return on investment), 577-578 Role-based access control, 215 Rootkit revealers, 146 Rootkits, 145-147 Roundoff error, 3%145 Router access controls, 464-466 Routers, 387 Routing concepts, 393 RSA (Rivest-Shamir-Adelman) encryption cryptanalysis of, 772 cryptographic challenges, 772-773 description, 769 Euler totient function, 769-771 Jacobi function, 771-772 key choice, 769 mathematical foundations, 769-771 overview, 77-78, 767-769 using the algorithm, 771-772 Rule-based ethics, 697-698 Rule-deontology, 697-698 Rules of evidence, 680 Rules of property, 679-680 Rules set, firewall, 477 Russian nuclear weapons, tracking, 140

Salami attack, 19 Salt extension, 228 Sandbox, 435 SAS Institute, 353 Satellite networks description, 384–385 eavesdropping, 411 wiretapping, 411 Satisfiability, cryptography, 719 S-boxes, 739, 740

Scanners port, 405 virus, 124 Schecter, Stuart, 598 Schell, Roger, 178 Schema, database, 320 Schneier, Bruce, 599 SCOMP, 191, 311 Scrambling data. See Cryptography; Encryption. Screening router, 475-476, 480 Script kiddies, 438 Scripts, 434-435 Secrecy. See Confidentiality; Privacy. Secret key encryption. See Symmetric encryption. Secure encryption algorithms, 60-62 Secure Hash Algorithm (SHA), 80 Secure Hash Standard (SHS), 80 Secure MIME (S/MIME), 496 Secure shell (SSH), 453 Secure Sockets Layer (SSL), 453-454 Security as add-on, 312 associations, 454-455 audits, 180 availability, 10, 12 confidentiality, 10-11. See also Privacy. definition. 1-2 features, 266-273 goals, 10-12 integrity, 10, 11-12 kernel, 274 money versus information, 2 physical. See Physical security. versus precision, databases, 339-341 software. See Operating system security; Programs, security. targets, 306 value of. See Economics of cybersecurity. weaknesses. See Vulnerabilities. Security models Bell-La Padula, 254-256 Biba integrity, 256 command structure, 259 conditions, 259 definition, 243 Graham-Denning, 257-259 Harrison-Ruzzo-Ullman, 259-261 integrity \*-property, 256 lattice model, 253-254 leaking access rights, 261 lower bound, 254

multilevel security, 253-257 partial ordering, 254 primitive operations, 259-260 \*-property (star property), 255-256 protection system commands, 258 protection systems, 260 relational operators, 254 simple integrity property, 256 simple security property, 255-256 Take-Grant, 261-263 theoretical limitations of systems, 257-263 upper bound, 254 uses for, 252-253 write-down, 256 Security parameter index (SPI), 455 Security plan. See also Risk analysis; Security policies. business continuity plan, 518-521 commitment to, 517-518 constraints, 512-514 contents of, 510-516 continuing attention, 516 controls, 512-514 current status, 511-512 definition, 509 framework for, 511 history of, 509 incident response plans, 521-524 incident response teams, 522-523 OCTAVE methodology, 511 policy statement, 510-511 requirements, 512-514 responsibilities, 514-516 team members, 517 timetable, 516 Security policies. See also Policies; Principles; Security plan. access triples, 250 audience, 547-548 beneficiaries, 548 characteristics of, 549-550 Chinese Wall, 251-252 Clark-Wilson commercial, 250 classification, 248 commercial, 248-250 compartments, 246 constrained data items, 250 contents, 548-549 definition, 243, 245, 547 dominance, 248 durability, 550 economics of, 551 examples data sensitivity, 551

DOE (Department of Energy) policy, 551-552 government e-mail, 553 Internet policy, 552-553 hierarchical, 248 issues, 554-555 kneed-to-know, 246 military, 246-248 nonhierarchical, 248 owners, 548 purpose, 547 realism, 550 separation of duty, 250-251 transformation procedures, 250 usefulness, 550 users, 547-548 well-formed transactions, 250 Segment address table, 199 Segment address translation, 199 Segmentation combined wit paging, 203-204 networks, 442-443 overview, 199-202 Selective backups, 564 Selective protection. See Tagged architecture. Self-healing code, 184 Self-stabilizing code, 184 Selling correct software, 673-674 Semiweak keys, 745-746 Senders, 38 Sendmail flaw, 135-136 Sensitive data data mining, 368 databases access acceptability, 337-338 access decisions, 337-338 authenticity, 338 bounds disclosure, 338 characteristics of, 336-337 data availability, 337 definition, 335 disclosures, types of, 338-339 exact data disclosure, 338 existence disclosure, 339 negative result disclosure, 339 overview, 335-337 probable value disclosure, 339 security versus precision, 339-341 overview, 604-605 Sensitivity lock, 359 Separation of duty, 250-251 multilevel databases, 356-359 overview, 190-193

principles of trusted systems, 279-280 of privilege, 266 Serialization error, 103 Serpent algorithm, 749 Servers, network, 378-379 Server-side includes, 427 Service, denial of. See DDoS; DoS. Service Set Identifier (SSID), 466-467 Session hijacking, 419-420. See also Impersonation. Sessions, network, 429 Set userid (SUID), 218-219 SHA (Secure Hash Algorithm), 80 Shadow fields, 332 Shadow values, 331-332 Shakespeare, authorship debate, 353 Shannon, Claude, 60 Shape, networks, 381-382 Shared resource matrix, 157-158 Sharing access, 323 enforced, 267 network threat, 397 session keys, 454 Shell backups, 565 Shift row, 751-752 Shneiderman, Ben, 515 Shopping online, privacy, 634-635 Shredding paper data, 562 SHS (Secure Hash Standard), 80 Signaling through images. See Steganography. Signature-based intrusion detection, 485, 486 Signatures, viruses definition, 124 execution patterns, 125-126 polymorphism, 127-128 scanners, 124 storage patterns, 125 transmission patterns, 126-127 Signed code, 456-457 Silken codes case study, 41 Simple integrity property, 256 Simple knapsacks, 760-761, 763 Simple remailers, 637 Simple security property, 255-256 Single point of failure, networks, 377, 443-444 Single sign-on, 214, 232 Size, networks, 381-382 Skype, 642 Smart cards, 560 S/MIME (Secure MIME), 496

SMTP (simple mail transport protocol), 392 Smurf attack, 428-429 SNMP (simple network management protocol), 392 Social engineering, 405-406 SOE (Special Operations Executive), 48 Software. See also Application; Code; Programs. access control, 15 configuration management, 15 controls. See Controls, software development. failure, legal issues full disclosure, 675-676 overview, 673 quality demands, 674-675 quality software, 678-679 refunds, 674 reporting flaws, 675-679 selling correct software, 673-674 user interests, 676 vendor interests, 676 warranty of cyberworthiness, 675 malicious modification, 15-16 security. See Operating system security; Programs, security. Sony XCP (extended copy protection) rootkit, 145-147 Source code, legal issues, 661-662 Source quench protocol, 438 Soviet Union codes, 59 Spafford, Eugene, 296 Spam, 598-599, 638 Special Operations Executive (SOE), 48SPI (security parameter index), 455 Spikes, electrical, 558 Spoofing. See also Impersonation. cryptographic protection, 462-463 e-mail. 638 interface illusions, 148-149 network vulnerability, 418 trusted path, 270-271 "Spray paint" lock, 357-359 Spying, 402, 683 Spyware, 632-634 SSH (secure shell), 453 SSID (Service Set Identifier), 466-467 SSL (Secure Sockets Layer), 453-454 Stack pointer, 106 Standards. See also Policies; Principles. IEEE Standard 729, 100

#### Index

841

process, 180-181 software development, 178, 180 Star property (\*-property), 255-256 State constraints, 334-335 State-based intrusion detection, 487 Stateful inspection firewalls, 477-478 Static code analysis, 174 Statistical analysis, intrusion detection, 486 Statistical inference attacks, 347 Statistics, computer crime, 21 Status accounting, 176 Statutes, 667, 683-686. See also Laws. Stealth mode intrusion detection, 487-488 Steganography, 159–160 Stevens, Thomas, 28 Stoll, Cliff, 137, 468 Stopford, Charlie, 621 Storage channels, 152-155 Stream ciphers, 62-63 Strong authentication, 459-464 Subjective probability, 534 Subschema, database, 320 Substitution, symmetric encryption, 730 Substitution ciphers book ciphers, 52-54 Caesar cipher, 44-46 complexity, 47-48 cryptanalysis, 48-49 cryptographer's dilemma, 49 keys, 47 one-time pads, 50-54 permutations, 46-47 random number sequences, 50 Vernam cipher, 50-52 Vignère tableau, 50, 53 Substitution cycle, DES, 734 Substitutions, 43 SUID (set userid), 218-219 Sum attacks, 343 Summer Study on Database Security, 357 Superincreasing knapsacks, 760-761, 763-764 Suppression control, 347 Surge suppressors, 558-559 Surges, electrical, 558 Surrounding viruses, 118-119 Surveys of security Australian Computer Crime and Security, 582

Surveys of security (continued) CSI/FBI Computer Crime and Security, 582 Deloitte and Touche Tohmatsu Global Security, 582-583 Ernst and Young Global Information Security, 583-584 IC3 (Internet Crime Complaint Center), 584 Imation Data Protection, 584-585 sources for, 585 Swallow, William, 404 Symantec, 125, 147-148 Symbols, organizational, 592 Symmetric encryption. See also AES; DES; Private key encryption. algorithms, 62 authentication, 62 confusion, 730 cryptographic challenges, 756-757 definition, 39 diffusion, 730 flow diagram, 40 key distribution, 62 key management, 62 overview, 62 permutation, 730 problems with, 730-732 RC2 cipher, 754-755 RC4 cipher, 755-756 RC5 cipher, 756 substitution, 730 SYN flood, 429 Synchronization, 267 SYN\_RECV connections, 429 System complexity, 397 System security policy. See Security policies. System testing, 295. See also Testing. Tagged architecture, 196–199 Take-Grant security model, 261-263 Tapping wires, 408-414, 416 Target of evaluation (TOE), 303 Target phrases, 301 TCB (trusted computing base), 245, 275 - 279TCP (Transmission Control Protocol), 391-392 TCP/IP protocol, 391-393 TCSEC (Trusted Computer System Evaluation Criteria), 297-300, 304

Teardrop attacks, 430

Telang, Rahul, 598 Teleological theory, 696-697 Telnet, 392, 477, 525 Tempest program, 562-563 Temporal Key Integrity Program (TKIP), 467-468 Temporal separation, 191, 279-280 Temporary permissions, 218-219 Ten Commandments of Computer Ethics, 713 Terrorists computer criminals, 23-24 cyberterrorism, 403 screening airline passengers, 615 Testing code acceptance, 170-171 assuring trusted systems, 290-291 black-box, 170 clear-box, 170-171 debugging, 142 formal methods, 179 independent, 172 installation, 170 integration, 142, 170 peer reviews, 165-168 penetration, 172, 177, 291 performance, 170 regression, 170 reviews, 168, 295 tiger team, 172, 177, 291 unit, 142, 170 walk-throughs, 166 Text analysis, computerized, 353 TFN (Tribal Flood Network), 401, 432 TFN2K, 401, 432 TGS (ticket-granting server), 213-214 The Internet, 395-396 Theft of service, 408, 412 Theft prevention, 559-561 Theorem provers, 292 Theoretical limitations of systems, 257-263 Third-party ads, 628-629 Third-party cookies, 630-631 Thompson, Ken, 136 Threats definition, 6 e-mail, 491 fabrications, 7-8 interceptions, 7-8 interruptions, 7-8 modifications, 7-8 to networks. See Networks, threats. types of, 7-8

versus vulnerabilities, 6

Ticket-granting server (TGS), 213-214 Tickets, networks, 461 Tiger team testing, 172, 177, 291 Tight versus loose organizational control, 595 Time bombs, 116 Time-dependent value of information, 664-665 Timelines, quantifying security value, 581 Time-of-check to time-of-use flaws, 288 Timestamps, 463 Timetable for security planning, 516 Timing attacks, 150 Timing channels, 155-156 TKIP (Temporal Key Integrity Program), 467-468 TLS (transport layer security), 453-454 TOE (target of evaluation), 303 Tokens, password, 459-460 Top-level domain, 393 Topography, networks, 381-382 Torch Concepts, 612-613 Tort law, 667-668 Totient function, 769-771 Tracker attacks, 345-346 Tracking Russian nuclear weapons, 140 Trade secrets, 658-659, 660, 672 Trademark, 662 Traffic flow analysis, 422 Traffic flow security, 469-470 Traffic redirection, 430 Training, privacy principles and policies, 618 Transferability, evaluating, 303 Transferring models, 589-590 Transformation procedures, 250 Transient viruses, 114 Transition constraints, 335 Transmission Control Protocol (TCP), 391-392 Transmission failure, 427 Transmission medium, 38 Transmitting e-mail, 636 Transport layer security (TLS), 453-454 Transposition. See Permutation. Trapdoors causes of, 144 definition, 16, 116 error checking, 142-143 examples, 142-144 integration testing, 142

undefined opcodes, 143-144 unit testing, 142 Tribal Flood Network (TFN), 401, 432 Triggering viruses, 117-119 Trigrams, 56-57 Trin00, 432 Triple DES, 71 Tripwire, 488 Trojan horses, 16, 116 Trust. See also Trusted systems, design principles. definition, 243 as economic issue, 592-593 threshold, 85 through common respected individual, 85-87 without a single hierarchy, 89-91 Trusted authentication, 418 Trusted Computer System Evaluation Criteria (TCSEC), 297-300, 304 Trusted computing base (TCB), 245, 275-279 Trusted front-end, 360-361 Trusted path, 270-271 Trusted processes, 245 Trusted product, 245 Trusted software, 245 Trusted systems. See also Operating system security; Programs, security. appropriate confidence level, 244 characteristics of, 244 definition, 242 design principles. See also Trust. access control, 266 accountability, 272 allocation of general objects, 266-267 assurance, 268 audit, 272 audit log reduction, 272-273 complete mediation, 265-266, 270 cryptographic separation, 279-280 DAC (discretionary access control), 269-270 definition, 243 ease of use, 266 economy of mechanism, 265 enforced sharing, 267 execution domain switching, 276 guaranteed fair service, 267 hierarchical structuring, 285-287 identification, 269

importance of, 264 intrusion detection, 273 I/O operation, 277 isolation, 279-280 kernelized design, 274-279 layered trust, 283-287 least common mechanism, 266 least privilege, 265 logical separation, 279-280 MAC (mandatory access control), 269-270 magnetic remanence, 270 memory protection, 266, 277 multiple virtual memory spaces, 281 object reuse, 270 open design, 265 operating system data protection, 267-268 permission based, 266 physical separation, 279-280 process activation, 276 reference monitor, 275 security features, 266-273 separation, 279-280 separation of privilege, 266 synchronization, 267 system elements, 265-266 TCB (trusted computing base), 275-279 temporal separation, 279–280 trusted path, 270-271 user authentication, 266, 269 virtual machines, 282-283 virtual memory, 282 virtualization, 280-283 enforcement of integrity, 244 functional correctness, 244 limited privilege, 244 overview, 243-245 qualities of, 245 versus secure, 244 security models Bell-La Padula, 254-256 Biba integrity, 256 command structure, 259 conditions, 259 definition, 243 Graham-Denning, 257-259 Harrison-Ruzzo-Ullman, 259-261 integrity \*-property, 256 lattice model, 253-254 leaking access rights, 261 lower bound, 254 multilevel security, 253-257

partial ordering, 254 primitive operations, 259-260 \*-property (star property), 255-256 protection system commands, 258 protection systems, 260 relational operators, 254 simple integrity property, 256 simple security property, 255-256 Take-Grant, 261-263 theoretical limitations of systems, 257 - 263upper bound, 254 uses for, 252-253 write-down, 256 security policies access triples, 250 Chinese Wall, 251-252 Clark-Wilson commercial, 250 classification, 248 commercial, 248-250 compartments, 246 constrained data items, 250 definition, 243, 245 dominance, 248 hierarchical, 248 kneed-to-know, 246 military, 246-248 nonhierarchical, 248 separation of duty, 250-251 transformation procedures, 250 well-formed transactions, 250 trust, definition, 243 underpinnings of, 242-243 Trusted systems, assurance evaluation action phrases, 301 British criteria, 301-302 claims language, 301 CLEFs (Commercial Licensed Evaluation Facilities), 302 Combined Federal Criteria, 304-307 Common Criteria, 307-308 comparability, 303 criteria development, 309-311 effectiveness, 303 emphatic assertion, 311 Europe, 300-303 German Green Book, 300-301 ITSEC (Information Technology Security Evaluation Criteria), 300-303, 303-304

#### Index

843

Trusted systems, assurance (continued) evaluation(continued) marketability, 303 overview, 296-297 process description, 309 protection profiles, 305 security, as add-on, 312 security targets, 306 summary of criteria, 308-311 target phrases, 301 TCSEC (Trusted Computer System Evaluation Criteria), 297-300, 304 TOE (target of evaluation), 303 transferability, 303 United States, 297-300, 304-307 flaws ambiguous access policies, 288 exploitation examples, 289-290 incomplete mediation, 288-289 known vulnerabilities, 288-289 time-of-check to time-of-use flaws, 288 typical flaws, 288-290 user interface vulnerability, 288 methods formal verification, 292-294 penetration testing, 291 requirements checking, 295 reviews, design and code, 295 system testing, 295 testing, 290-291 theorem provers, 292 validation, 295 open source, 295-296 overview, 287-288 Tunnels, network encryption, 449-450 Turing machines, 721 12-step password attacks, 226 Two-factor authentication, 222 Twofish algorithm, 749 Two-phase update, 330-332 UCC (Uniform Commercial Code), 674-675 UDP (user datagram protocol), 391-392

Unauthorized access, 559 Undefined opcodes, 143–144 Unexpected behavior, 101–103 Uninterruptible power supply (UPS), 558 Unit testing, 142, 170. *See also* Testing, United Kingdom cost of security incidents, 586 RIPA (Regulation of Investigatory Powers Act), 287 United States California Breach Act, 686 CAN SPAM Act, 685-686 Census Bureau, 341 Computer Fraud and Abuse Act, 683 Economic Espionage Act, 683 Electronic Communications Privacy Act. 684 Electronic Funds Transfer Act, 683 evaluating trusted systems, 297-300, 304-307 Freedom of Information Act, 684 GLBA (Graham-Leach-Bliley Act), 684 government audit data overload, 273 security report card, 29 HIPAA (Health Insurance Portability and Accountability Act), 684-685 laws. See Laws, U.S.. Patriot Act, 685 Privacy Act, 684 privacy principles and policies, 610-611 Universality of ethics, 694-695 Universities, as prime targets, 9 Unknown path, 399 Unknown perimeter, 398-399 Unshielded twisted pair (UTP) cable, 382 Upper bound, 254 UPS (uninterruptible power supply), 558 URLs, legal issues, 662 Usage controls on cryptography, 688-690 Use of computer services, ethical issues, 698-699 Usefulness, 550 User authentication. See also Authentication. additional authentication information, 221-222 biometrics, 219-220, 234-236 challenge-response system, 231-232, 233-234 cookies, 236 databases, 328

flaws, 233-234 versus identification, 234-235 impersonating trusted systems, 236 impersonation of login, 233-234 multifactor authentication, 222 one-time passwords, 231-232 overview, 219 password attacks, 222-229 password selection criteria, 229-231 passwords as authenticators, 221 phishing, 236 principles of trusted systems, 266, 269 process description, 232-234 single sign-on, 232 two-factor authentication, 222 User datagram protocol (UDP), 391-392 User interests, 676 User interface vulnerability, 288 User-group-world protection, 218 Users human fallibility case study, 67 security policies, 547-548 security responsibilities, 514 Utilitarianism, 697 UTP (unshielded twisted pair) cable, 382 V.A. (Veterans Administration), 14 Validation, 295 Validation errors, 103 Value of data, 681 Value of security. See Economics of cybersecurity. VAM (Vulnerability Assessment and Mitigation), 527, 537-542 Vandalism, 559-561 Varian, Hal, 597 Vendor interests, 676 Verifying program code. See Testing code. Verisign, 22, 229, 457 Vernam, Gilbert, 50 Vernam cipher, 50-52 Version proliferation, databases, 327 Views, multilevel databases, 363-366 Vignère tableau, 50, 53 Virtual machines, 282-283 Virtual memory, 282 Virtual private networks (VPNs), 449-450 Virtualization, 280-283 Virus scanners, 124

Viruses. See also Malicious code. appended to a program, 118 application programs, 124 attachment, 117-119 benign, 132-133 boot sector, 122 bootstrapping, 122 Brain, 133-134 Code Red, 137-139 cookies, 140 defense methods, 129-131 definition. 16 document, 119-120 effects and causes, 127-128 e-mail attachment, 117-118 gaining control, 120-121 homes for, 121-124, 131-132 infecting hardware, 132 integrated, 119 Internet worm, 134-137 libraries, 124 memory-resident, 123-124 misconceptions, 131 one-time execution, 122 platform limitations, 131 qualities of, 121 in read-only files, 131 resident, 114-116 signatures definition, 124 execution patterns, 125-126 polymorphism, 127-128 scanners, 124 storage patterns, 125 transmission patterns, 126-127 source of. 128-129 spreading media, 132 surrounding a program, 118–119 surviving power off, 132 transient, 114 triggering, 117-119 web bugs, 139-141 Voice recognition authentication. See **Biometrics** VoIP (Voice over IP), 642 Voting, electronic, 641-642 VPNs (virtual private networks), 449-450 Vulnerabilities. See also Attacks; specific vulnerabilities. data, 16-19 definition, 6 hardware, 13-15 laptop computers, 14-15

mapping to controls, 537 network threat, 397–399, 438 risk analysis, 527–531 software, 15–16 *versus* threats, 6 Vulnerability Assessment and Mitigation (VAM), 527, 537–542

Walk-through, code, 166 WAN (wide area network), 395 War driving, 408 Ware, Willis, 609-610 Ware committee report, 610 Warranty of cyberworthiness, 675 Watermarking, 93-94 Weak keys, DES, 745 Weak passwords, 224-227 Weakest link principle, 29-30 Weakest point, 5 Weakness. See Risk analysis; Risks; Threats; Vulnerabilities. Weaknesses, 66-67 Web bugs, 139-141, 631 Web servers, escape-character attack, 434-435 Web sites. See also Internet. content, legal issues, 662 defacing, 424-425 posting privacy policies, 611 privacy advertising, 628-629 adware, 633-634 contests, 629 cookies, 629-631 credit card payments, 627 drive-by installation, 634 highjackers, 632-633 keystroke loggers, 632 offers, 629 online environment, 626-627 online profiling, 631 payment schemes, 627 payments online, 627 precautions, 629-631 registration, 628 shopping, 634-635 site ownership, 628-629 spyware, 632-634 third-party ads, 628-629 third-party cookies, 630-631 web bugs, 631 privacy controls, commercial, 612-613 privacy controls, government, 611

#### Index

845

tracking usage, 396 vulnerabilities, 424-427 Well-formed transactions, 250 Well-known authentication, 417-418 WEP (wired equivalent privacy), 467 White-box testing, 170-171 Wide area network (WAN), 395 WiFi. See Wireless. WiFi Protected Access (WPA), 467-468 Wild cards, 208-210 Wilshire Associates, e-mail theft, 28 Windows, distributed authentication, 398 Windows, multilevel databases, 363-366. See also Views. Wireless networks description, 383 eavesdropping, 411-413 interception, 412 rogue access points, 408 security, 466-468 theft of service, 408, 412 vulnerabilities, 413 vulnerabilities, case study, 413 war driving, 408 wiretapping, 411-413 Wiretapping, 408-414, 416 Woods, Alan, 452 Word, deleting text, 271 Work for hire, 671 Workstations, 379 World War II case studies ASINTOER code, 59 Enigma code machine, 67 Japanese codes, 42 poem codes, 48 silken codes, 41 Soviet Union codes, 59 Worms. See also Malicious code; Viruses. Code Red, 137-139, 675-676 definition, 116 Internet worm, 134-137 WPA (WiFi Protected Access), 467-468 Write-down, 256 XCP (extended copy protection)

rootkit, 145–147 Xu, Hao, 598

Zero day exploits, 116 Zimmerman, Phil, 691 Zombie, 431–432 6468indx.qxd\_lb 9/21/06 5:01 PM Page 846

Œ

Æ

# **Register** Your Book

## at www.awprofessional.com/register

You may be eligible to receive:

- Advance notice of forthcoming editions of the book
- Related book recommendations
- Chapter excerpts and supplements of forthcoming titles
- Information about special contests and promotions throughout the year
- Notices and reminders about author appearances, tradeshows, and online chats with special guests

## **Contact us**

If you are interested in writing a book or reviewing manuscripts prior to publication, please write to us at:

Editorial Department Addison-Wesley Professional 75 Arlington Street, Suite 300 Boston, MA 02116 USA Email: AWPro@aw.com Addison-Wesley

Visit us on the Web: http://www.awprofessional.com



## THIS BOOK IS SAFARI ENABLED

## **INCLUDES FREE 45-DAY ACCESS TO THE ONLINE EDITION**

The Safari<sup>®</sup> Enabled icon on the cover of your favorite technology book means the book is available through Safari Bookshelf. When you buy this book, you get free access to the online edition for 45 days.

Safari Bookshelf is an electronic reference library that lets you easily search thousands of technical books, find code samples, download chapters, and access technical information whenever and wherever you need it.

#### TO GAIN 45-DAY SAFARI ENABLED ACCESS TO THIS BOOK:

- Go to http://www.prenhallprofessional.com/safarienabled
- Complete the brief registration form
- Enter the coupon code found in the front of this book on the "Copyright" page



If you have difficulty registering on Safari Bookshelf or accessing the online edition, please e-mail customer-service@safaribooksonline.com.

## Wouldn't it be great

if the world's leading technical publishers joined forces to deliver their best tech books in a common digital reference platform?

## They have. Introducing InformIT Online Books powered by Safari.

### Specific answers to specific questions.

InformIT Online Books' powerful search engine gives you relevance-ranked results in a matter of seconds.

### Immediate results.

With InformIT Online Books, you can select the book you want and view the chapter or section you need immediately.

## Cut, paste and annotate.

Paste code to save time and eliminate typographical errors. Make notes on the material you find useful and choose whether or not to share them with your work group.

## Customized for your enterprise.

Customize a library for you, your department or your entire organization. You only pay for what you need.

## Get your first 14 days FREE!

For a limited time, InformIT Online Books is offering its members a 10 book subscription risk-free for 14 days. Visit **http://www.informit.com/onlinebooks** for details.





informit.com/onlinebooks



# **inform**

## www.informit.com

## YOUR GUIDE TO IT REFERENCE



## Articles

Keep your edge with thousands of free articles, indepth features, interviews, and IT reference recommendations – all written by experts you know and trust.

## **Online Books**

Answers in an instant from **InformIT Online Book's** 600+ fully searchable on line books. For a limited time, you can get your first 14 days **free**.





## Catalog

Review online sample chapters, author biographies and customer rankings and choose exactly the right book from a selection of over 5,000 titles.