
Index

- 5G networks, 293
- Adleman, Leonard, 192
 aether, 493
 Aftergood, Steven, 419
 Air Force Office of Scientific Research, 446
 Akers, Timothy, 384
 Al-Qaeda, 338
 Al-Shabaab, 338
 Alfred P. Sloan Foundation, 447
 Amazon.com, Inc., 181; Bracket quantum cloud, 181
 Antarctic Treaty System, 424
 anti-satellite weapons, 423
 AO Sense, Inc., 68
 Apple Inc., 392
 Applied Diamond Inc., 41
 area 51, 157
 Argonne National Laboratory, 384
 Army Research Laboratory, 70
 Army Research Office, 446
 ARPANET, 149
 ArQit, Ltd., 289
 artificial intelligence; winter, 397
 atomic clock, 36, 472
 atomic vapor sensors, 41
- Babbage, Charles, 79
 Badische Anilin und Soda Fabrik, 183
 Barlow, John Perry, 377, 396
 Bartholinus, Erasmus, 505
 Bayerische Motoren Werke AG (BMW), 390
 BeiDou Navigation System, 51
 BEIT Inc., 224
 Bell tests, 298, 517
 Bell, John Stewart, 517
 Bellovin, Steven, 430
 Benioff, Paul, 160, 161
 Bennett, Charles H., 135, 152, 168
- Bergius, Friedrich, 183
 Bertin Technologies SAS, 38
 Big Bang, 492
 biological weapons, 332
 Bitcoin, 284
 black-body radiation, 493
 Bletchley Park, 80, 93, 393
 blind signal separation, 437
 blockchain, 273
 Bluefors Oy, 415
 Boeing Company, 411
 Bohm, David, 523
 Bohr, Niels, 472
 Bolt Beranek & Newman (BBN), 149, 393
 Boneh, Dan, 192
 Booz Allen Hamilton Inc., 390
 Born, Max, 498
 Bosch, Carl, 183
 Boudot, Émile, 89
 Bra-ket notation, 231
 brain-machine interface, 63
 Brassard, Gilles, 137
 Brazil, 447
 Bremerman, Hans, 160
 British Telecom (BT Group Plc), 390
 Brookhaven National Laboratory, 70, 384
 Bryans, Nathaniel, 205
 buckyballs, 497
 Buettiker, Markus, 160
 Burks, Arthur, 136, 160
 Bush, Vannevar, 83
- Canada; quantum patents, 451
 CCNOT, 153
 celestial navigation, 55
 cellular automata (CA), 136, 142;
 blinker, 141; computation in
 memory, 139; emergent complex-
 ity, 140; glider, 142; Life, 140;

 INDEX

- Life Turing Machine, 144; quines, 139
- Central Intelligence Agency, 322
- Chaitin, Gregory, 160
- Charles Stark Draper Laboratory, 55
- chemical vapor deposition, 41
- Chiang, Ted, 147
- China, 287, 380, 400, 446; decoupling, 251; internet censorship, 377; investment in QIS, 451; Micius Satellite, 287; National Natural Science Foundation of China, 446; Quantum Experiments at Space Scale program (QuESS), 288; quantum patents, 451; SIG-INT capabilities, 267; technology decoupling, 416; Thousand Talents Programs, 418
- Chong, Frederic, 384
- Chopra, Deepak, 370
- Chu, Steven, 36
- Chuang, Isaac, 203
- Church–Turing hypothesis, 94
- circular economy, 397
- Clark, Charles, 167
- Clarke, James S., 384
- cloud computing, 119, 156; embarrassingly parallel workloads, 187; Entropy as a Service (EaaS), 276
- Cocke, John, 160
- Cocks, Clifford, 191
- Cohen-Tannoudji, Claude, 36
- ColdQuanta, Inc., 75, 230
- Colossus computer, 179
- complementarity, 505
- complexity theory, 108; Big-O notation, 105; bounded-error quantum polynomial time (BQP), 226; BQP algorithms, 116, 181; certificate, 108; decision problem, 108; NP-complete, 111; NP-hard, 113; polynomial complexity, 107; primality testing, 113; traveling salesperson problem (TSP), 107
- Comprehensive Nuclear-Test-Ban Treaty, 189
- computer simulations; repeatability, 158; scalability, 157; speed, 157
- computers; calculation versus computing, xviii; classical, 110; cloud versus supercomputing approach, 237; core, 139; gates, 153; graphical processing units (GPUs), 118; industrial policy, 86, 157, 158, 393; multi-core systems, 118; optimizers, 115; parallel computing, 155; reversible computers, 124; reversible gates, 153; reversible Turing machine, 135
- Conference on the Physics of Computation (1980), 160
- Conway, John Horton, 140
- Copenhagen interpretation, 523
- copyright; circumvention, 433
- corpuscles, 488
- Crutchfield, James, 160
- Cryogenic Ltd., 39
- cryogenics, 251
- Cryomech Inc., 415
- cryptanalysis, 429; brute force attack, 197, 218; certificate attacks, 322; DES Cracker, 216; differential cryptanalysis, 212; DigiNotar, 322; discrete logarithm, 203; Grover’s algorithm, 218; hash collisions, 321; prohibitions on, 429; quantum attack forecasts, 206
- cryptography, 190; Advanced Encryption Standard (AES), 212, 217, 277; BB84, 277; caesar cipher, 190; Clipper Chip, 217; computationally secure systems, 257; cryptogram, 191; cryptographic hash, 317; DES algorithm, 212; Diffie–Hellman algorithm, 202; digital signatures, 193; Easy Email Encryption (E3), 430; forward secrecy, 202, 277, 430; hash functions, 195; information-theoretic secure approaches, 277; information-theoretic security, 257; key escrow, 217; key length, 213; Lucifer algorithm, 212; one-time pad, 277; Open Quantum Safe Project, 431; OpenQKD Project, 292; passphrase, 317; post-quantum cryptography, 431; pseudorandom random number generators, 274; public key, 191; public key infrastructure, 194; repeater trust, 296; RSA-129, 262; secret key, 190; symmetric ciphers, 211; triple-DES, 212; trusted couriers, 290; unconditional security, 277;

- usability challenges, 271; Vernam cipher, 191
 cybernetics synergy, 351
- D-Wave Systems, Inc., 239
 D5: disruption, denial, degradation, destruction, and deception, 344
 Daemen, Joan, 217
 dark fiber, 289
 Dattani, Nikesh, 204
 De Beers Group SA, 63
 de Broglie, Louis-Victor, 495
 de Sola Pool, Ithiel, 377
 decoherence, 32
 Defense Advanced Research Projects Agency (DARPA), 150, 158, 167
 Defense Intelligence Agency (DIA), 75
 Denso Corp., 390
 Department of Defense (US), 383
 Department of Energy, 383
 deterrence theory, 309, 424; criminal deterrence, 438; defend forward, 425; nuclear triad, 61; Strategic Defense Initiative, 332; strategic surprise, 315
 Deutsch, David, 164
 Didion, Joan, 392
 Diffie, Whitfield, 191
 digital discipline, 132; refresh operation, 132
 Digital Equipment Corp., 149
 digital physics, 146, 154; arrow of time, 126; decoherence, 130; free will, 126, 147
 Dirac, Paul, 231
 DiVincenzo, David P., 225, 231
 DLR, 390
 DNA-based computing, 207
 Doppler, Christian, 490
 Dowling, Jonathan, 472
 drones, *see* unmanned aerial vehicle (UAV)
 dual-slit experiment, 489
 Dyakonov, Mikhail, 244, 366
 Dyson, Freeman, 160
- Eames, Charles and Ray, 475
 Einstein, Albert, 472
 electromagnetically induced transparency, 41
 Electronic Discrete Variable Automatic Computer (EDVAC), 106
- Electronic Frontier Foundation, 216
 Electronic Numerical Integrator and Computer (ENIAC), 86
 electronic warfare, 55, 339
 ELIZA, 99
 Ellis, James, 191
 Endicott House Conference, 122
 ENIGMA, 94
 entropy, 128
 Entscheidungsproblem, 94
 EPR paper, 515
 Euler's Theorem, 201
 Europe; investment in QIS, 451
 European Convention on Human Rights (ECHR), 438
 European Organization for Nuclear Research (CERN), 253, 400
 European Space Agency, 67
 European Union, 381
 export controls, 420
 eye-in-the-sky monitoring, 426
- Fano, Roberto Mario, 146
 Farrell, Henry, 313
 Federation of American Scientists, 419
 Feistel, Horst, 211
 Fermi National Accelerator Laboratory, 384
 Feynman diagrams, 125
 Feynman, Richard, 122, 160, 483
 Finke, Doug, 237
 Finland, 415
 firearm detection, 64
 Flobberth, Otto, 160
 France, 382
 Franklin, Matthew, 192
 Fredkin gate, 152
 Fredkin, Edward, 146, 160
 Fu, Kai-Mei, 384
 fullerenes, 497
- Gacs, Peter, 160
 Galileo Global Navigation Satellite System, 51
 Game of Life, *see* cellular automata (CA), 140
 game theory, 61, 424
 Gardner, Martin, 142, 261
 gates; electronic, 90; quantum, 152, 179, 232, 321; reversible, 153; universal, 91
 Gell-Mann, Murray, 151

 INDEX

- GEOINT Singularity, 426
 Germany, 382; Munich Quantum Valley, 382; quantum patents, 451
 Giustina, Marissa, 384
 GLObal Navigation Satellite System (GLONASS), 51
 Global Positioning Systems (GPS), 51; countermeasures, 54; quantum PNT, 54, 344; quantum positioning systems, 339; selective availability, 414
 Goddard, Robert, 55
 Goldman Sachs Group, Inc., 252
 Goldstone, Herman, 138
 Google LLC, 202, 417
 Gosper, Bill, 143, 160
 gradiometer, 39, 60
 gravitational waves, 65
 Gravity Recovery and Climate Experiment (GRACE), 67
 great decoupling, 455
 Greenberger, Dan, 160
 Greenspan, Donald, 160
 Grover's algorithm, 210, 430
 Grover, Lov, 210
 Guericke, Otto von, 489
 Gupta, Madhu, 160
- Haber, Fritz, 182
 Haber-Bosch process, 183
 Hanson, Ronald, 298
 Harari, Yuval Noah, 455
 Hardy, Norman, 160
 Haroche, Serge, 167
 Hassner, Marin, 160
 Hawking radiation, 146
 Hawking, Stephen, 146
 Hayek, Friedrich, 351
 Hebrew University of Jerusalem, 518
 Heisenberg, Werner, 472, 498
 helium, 251
 Hellman, Martin, 191
 Herrera, Gilbert, 384
 Hewitt, Carl, 160
 high modernism, 351
 high-dimensional datasets, 441
 Hillis, Danny, 101, 160, 161
 Hitachi, 497
 Holt, Anatol, 160
 Honeywell International Inc., 224
 Hopper, Grace, 180
 Hu, Evelyn, 384
 Huawei Technologies Co., Ltd., 380
- Hubble, Edwin Powell, 492
 human worth, 455
 hypersonic weapons, 338
 Huygen, Christiaan, 493
- ID Quantique SA, 276, 289
 Ig Nobel prize, 1998, 370
 immigration, 17; brain drain, 408; brain gain, 408
 In-Q-Tel, 386
 India, 382, 413
 industrial policy, 385; high-tech industries, 396; market proscription, 385, 415; market substitution, 385; picking winners and losers, 400; Silicon Valley, 392
 inertial navigation, 55
 InfiniQuant, 289
 information; binary, 87; bit, 89; byte, 89; digital, 87
 Information International Inc. (Triple I), 150
 Information Processing Techniques Office (ARPA), 150
 inherently political technologies, 306
 Intel Corp., 417
 intellectual property theft, 366
 Interface Message Processor (IMP), 149
 interferometer, 65
 interferometry, 43, 492
 International Business Machines Corp. (IBM), 81, 124, 157, 251, 253, 294, 417; IBM Research, 203; Lucifer algorithm, 211; quantum experience, 181
 International Emergency Economic Powers Act (IEEPA), 421
 International Traffic in Arms Regulations (ITAR), 420
 Internet of Things (IoT), 276
 inverse square law, 59
 ion traps, 246
 ISIS, 338
 Israel; Mossad, 322; Raicol Crystals Ltd., 416; Technion (Israel Institute of Technology), 165
- Jacquard Loom, 87
 Japan, 413, 415; quantum patents, 451
 JASON brain trust, 167
 Jordan, Stephen, 227

INDEX

- Josephson Junctions, 39
 Josephson, Brian David, 39
 Jozsa, Richard, 168
- Kantor, Frederick, 160
 Katabi, Dina, 361
 KETS Quantum Security, Ltd., 289
 Kim, Jungsang, 384
 Kohnfelder, Loren, 194
 Kugell, Stand, 160
- Landauer limit, 134
 Landauer, Rolf, 134, 160, 244
 Lanzagorta, Marco, 62, 73, 287, 314
 Large Hadron Collider, 253
 laser, 472
 Laser Interferometer Gravitational-Wave Observatory (LIGO) project, 43
 Laser Interferometer Space Antenna (LISA), 67
 Lawrence Berkeley National Laboratory, 384
 Leinweber, David, 160
 Levin, Leonid, 160
 Levitin, Lev, 160
 Lewis, Gilbert N., 495
 Lewis, Robert, 160
 LGP-30, 149
 Licklider, J. C. R., 146, 393
 Ligomenides, Panos, 160
 Lingham, Laurie, 160
 Lockheed Martin Corp., 390, 417
 Los Alamos National Laboratory (LANL), 189, 289, 390
 low-observable technology, 72
 Lu, Chao-Yang, 242, 465
 Lucent, 453
 Luhn, Hans Peter, 194
 Lykken, Joseph, 384
 Lysenkoism, 370
- machine learning; optimization, 239
 MagiQ Technologies, Inc., 289
 Magnetic Resonance Imaging, 37
 magnetometer, 39
 Makarov, Vadim, 292
 many-worlds interpretation, 523
 Margolus, Norman, 160
 Massachusetts Institute of Technology (MIT), 146, 152; Artificial Intelligence Laboratory, 158; Laboratory for Computer Science, 158; Lincoln Laboratory, 41, 148
 Mauritsen, Luke, 384
 Maxwell, James Clerk, 492
 McCarthy, John, 149
 measurement and signature intelligence (MASINT), 32, 75
 metadata, 340
 Michaels, George, 160
 Michelson Interferometer, 43
 Michelson, Albert A., 493
 microscopy; two-photon, 38
 Microsemi Corporation, 51
 Microsoft Corp., 244, 417
 Milburn, Gerald, 472
 Minsky, Marvin, 149
 MITRE Corp., 167
 Mitsubishi, 453
 Moler, Katherine, 384
 Monroe, Christopher, 384
 Monte Carlo methods, 189
 Moore's Law, 100
 Moore, Gordon, 100
 Moravec, Hans, 160
 Morley, Edward W., 493
 Morse code, 89
 multi-spectral analysis, 70
- NASA Ames Research Center, 390
 National Aeronautics and Space Administration (NASA), 383
 National Geospatial-Intelligence Agency (NGA), 75, 423
 National Institute of Standards and Technology (NIST), 167, 212, 273, 383
 National Institutes of Health (NIH), 372, 383
 National Reconnaissance Office (NRO), 75, 423
 National Science and Technology Council (NSTC), 383
 National Science Foundation (NSF), 372, 383
 National Security Agency, 157, 278, 286, 289, 292
 Netherlands, 447
 Newman, Abraham L., 313
 Newton, Isaac, 488
 Nippon Telegraph and Telephone Corporation (NTT), 289
 nitrogen fixation, 181
 nitrogen vacancy chambers, 41

 INDEX

- Nobel Prize; 1918, 182, 494; 1921, 494; 1929, 495; 1931, 183; 1965, 125; 1969, 151; 1997, 36; 2012, 167; 2017, 492
- North Korea, 293
- nuclear fusion, 400; ITER Thermonuclear Reactor, 400; tokamak, 400
- nuclear weapons, 138, 157, 189, 251, 253
- numeric coding, 84
- O'Mara, Margaret, 392
- Oak Ridge National Laboratory, 384, 390
- Ocado, 390
- Office of Science and Technology Policy (OSTP), 383
- Office of Foreign Assets Control (OFAC), 421
- Office of Naval Research, 446; contract N00014-75-C-0661, 158
- Office of the Director of National Intelligence (ODNI), 383
- Oliver, William, 384
- Open Skies Treaty, 333
- Operation Paperclip, 56, 380
- Orca Computing Ltd., 43
- Outer Space, Treaty of 1967, 422
- Packard, Norman, 160
- Pan, Jian-Wei, 242, 287, 298, 408, 465
- patent secrecy, 419
- patents, quantum, 451, 453
- paternalistic socialism, 417
- Pawlowski, Stephen, 384
- PDP-1, 149
- Peres, Asher, 165
- Perlroth, Nicole, 267
- Petri, Carl Adam, 160
- Phase Space Computing, AB, 289
- Philips, William D., 36
- photon; angular momentum, 509; angular position, 87; bucket detector, 70; entanglement, 27; polarization, 27; spin, 521
- photonic qubits, 246
- pilot wave interpretation, 523
- Planck, Max, 472, 494
- polarizer, 508
- Ponzi, Charles, 370
- Poplavskii, R. P., 164
- Positioning, Navigation, and Timing (PNT), 51
- Positron Emission Tomography, 38
- Pour-El, Marian, 160
- Powers of Ten* film, 475
- PQ Solutions Ltd., 431
- Preskill, John, 384
- Priese, Lutz, 160
- privacy; brain wiretapping, 63; data deletion, 431; Fourth Amendment, 433; metadata, 268; nothing to hide, 429; reidentification, 432; transsubstantive legal protections, 438
- Project MAC, 146
- Project Maven, 418
- Project Venona, 289
- PsiQuantum Corp., 43
- Pudenz, Kristen, 384
- Qatar, 251
- QBranch, 390
- QEYnet, Inc., 289
- Qrate Quantum Communications (Russia), 289
- Quantropi Inc., 289
- quantum; academic departments, 402; annealing, 239; applied research, 398; as “atom bomb” of information theory, 315; basic research, 381; chemistry, 185; complementary technologies, 289; countermeasures, 344; development, 398; export controls, 420; fiction, 473; high-dimensional information, 87; illumination, 43, 71; K–12 education, 411; marketization, 398; memory, 296; mysticism, 370; outer space, 55; patent holders, 453; quantum money, 284; radar, 71; research output, 446; strategic surprise, 315; threat analysis, 307; tunneling, 101; winter, 309, 397
- quantum advantage, 229
- quantum communication; D5 attack tactics, 299; outer space deployment, 288, 300; quantum internet, 293, 389; Quantum Key Distribution (QKD), 277; as a service, 286; on backhaul, 388; quantum memory router, 296; Quantum Random Number Generation (QRNG), 274; handset hardware,

INDEX

- 293; system-on-a-chip implementation, 292; quantum repeaters, 295; quantum teleportation, 296; superluminal communication, 300
- quantum computers; adiabatic quantum computation, 205; analog, 165, 239; as quantum sensor arrays, 235; blind quantum computing, 294; challenges, 243; circuits, 233; cloud implementations, 181, 432; computational chemistry, 185; digital noisy intermediate-scale quantum devices (NISQ), 235, 241; DiVincenzo criteria, 231; drug development, 442; error correction, 237, 247; fairness in machine learning, 444; Feynman's Endicott talk, 161; gate-controlled, 241; interference, 178; Jiuzhang Quantum Computer, 242, 416, 465; logical qubit, 237; misconceptions, 122; noise, 179; nondeterminism, 124; nondeterministic Turing machines, 122; parallels to early classical devices, 179; photonic, 242; physical qubit, 237; programming, 179; quadratic unconstrained binary optimization (QUBO), 238; Quantum Algorithm Zoo, 227; quantum circuit, 177; quantum error correction, 180; quantum memory, 74; Quantum volume, 224; qubit noise, 247; qubits, 123; Russia, 164; supercooling, 251; topological, 244; wave collapse, 178; winner take all, 242
- Quantum Computing Report, 237
- Quantum Design, Inc., 39
- quantum dots, 42, 246
- quantum error correction, 180
- quantum information science (QIS), 1
- quantum mechanics, 471; coherence, 29; complementarity, 26; Copenhagen interpretation, 356; entanglement, 26; first quantum revolution, 472; many-worlds interpretation, 356; philosophical implications, 145; photoelectric effect, 494; pilot wave interpretation, 356; quantum electrodynamics, 125; quantum gravity, 162; quantum reconstruction, 500; quantum tunneling, 122, 473; reductionist, 307; second quantum revolution, 472; superposition, 27; uncertainty, 26; wave-particle duality, 494
- quantum sensing; as quantum computers, 235, 242; first-generation approaches, 36, 38; outer space, 335; outer space deployment, 63, 67; quantum compass, 339; quantum illumination, 27, 68; Quantum Positioning System (QPS), 54, 344; quantum radar, 71; quantum sonar, 59; Rydberg atoms, 64; second-generation approaches, 39
- quantum supremacy, 229
- quantum volume, 252
- quantum winter, 366
- Quantum Xchange Inc., 289
- qubit, 168, 180; ancillary qubits, 234; coined, 168; stability, 179; topological, 180, 241, 244
- Qubit Reset, LLC, 289
- qubits; flying, 259; quantum dots, 43
- quines, 140
- QuintessenceLabs Pty Ltd., 289
- QuNu Labs Pvt. Ltd., 289
- qutrits, 87
- QZabre LLC, 41
- Rabkin, Jeremy, 422
- radar countermeasures, 72
- radiation portal monitor systems, 38
- radiation, black-body, 493
- Rand, Ayn, 396
- randomness beacon, 273
- Raytheon BBN Technologies Corp., 289, 393
- Raytheon Co., 149
- Recruit Communications, 390
- red shift, 492
- remote weapon detection, 437
- reversibility, 124; conservative logic, 159
- Richards, Ian, 160
- Rigetti & Co., Inc., 230, 400, 417
- Rigetti, Chad, 384
- Rijmen, Vincent, 217
- Ritter, Johann Wilhelm, 479
- Ritter, Mark, 384
- Rivest, Ronald, 192, 261

 INDEX

- Rothstein, Jerome, 160
 Royal McBee, 149
 Russell, Stuart, 338
 Russia, 382, 400, 426, 446;
 Gazprom, 251; GLONASS, 413;
 parallel innovation in quantum
 computing, 164; Russian armed
 forces, 55; SIGINT capabilities,
 267
 Rømer, Ole, 479
- scanning tunneling microscopy, 473
 Schoelkopf, Robert, 384
 Schrödinger's cat, 523
 Schrödinger, Erwin, 498
 Schumacher, Benjamin, 168
 Scott, James C., 351
 Second Law of Thermodynamics,
 128
 secrecy and time-value, 428
 Shamir, Adi, 192
 Shannon, Claude, 471
 Ship of Theseus thought experi-
 ment, 145
 Shor, Peter, 166
 Shostack, Adam, 307
 signals intelligence (SIGINT), 32;
 going dark, 295; golden age, 268;
 path-based attacks, 299
 Silk Belt and Road Initiative
 (China), 362
 Simons Foundation, 447
 Singapore, 447
Slaughterbots (video), 338
 smart cities, 353
 Smartquantum Group SA, 289
 software signatures, 322
 solar power, 307
 South Korea, 293; South Korea
 Telecom Co. Ltd., 293
 space (outer); launch-capable na-
 tions, 382; legal issues, 423; mil-
 itarization, 347, 423; strategic
 significance, 13, 55, 74, 288, 300,
 308, 312, 332, 333, 364, 422, 423
 Space Exploration Technologies
 Corp., 314
 Space Force, 55, 289
 Specially Designated Nationals and
 Blocked Persons List (SDN), 422
 Spin Exchange Relaxation Free
 magnetometry, 41
 squeezed light, 43
 stealth technology, 72
- Suaya, Robert, 160
 Subcommittee on Quantum Infor-
 mation Science (SCQIS), 383
 submarine detection, 60
 Sumitomo Heavy Industries, Ltd,
 415
 superconducting circuits, 246
 surveillance capitalism, 358
 Susskind, Leonard, 146
 Svore, Krysta, 384
 Swire, Peter, 268
- Tahan, Chares, 384
 tea, bitter, 128
 Technion (Israel Institute of Tech-
 nology), 165
 technology; cost, initial and incre-
 mental, 93; determinism, 306,
 377; government control strate-
 gies, 419; industrial policy, 292;
 military to law enforcement dev-
 olution, 426; neutrality, 306;
 path dependencies, 155; switch-
 ing costs, 155; technological
 dominance, 309; technological
 sovereignty, 414; technological
 superiority, 309; technological
 supremacy, 309; technology-
 neutral regulation, 438; theft,
 418; virtuous cycle, 17; winner
 take all, 242, 311
 telegraph, 89
 Telenet, Inc., 149
 Teletype, 94
 Theranos Inc., 370
 Thermodynamics, Second Law, 128
 Thiagarajan, S. P., 160
 Thinking Machines Corp., 164
 ThorLabs LLC, 43, 416, 465
 threat modeling, 307; STRIDE
 framework, 309
 TianQin observatory, 67
 time dilation, 50
 time-division multiplexing, 89
 Toffoli, Tommaso, 136, 160
 Toshiba Corp., 289
 transistor, 472
 Triple-I, 150
 Trump administration, 372
 Trusted Layer Security (TLS), 199
 Turing Complete, 93, 143
 Turing Test, 99
 Turing, Alan, 80, 93

INDEX

- Ulam, Stanislaw, 189
 ultraviolet catastrophe, 494
 uncertainty principle, 502
 underwater navigation, 58
 United Kingdom, 415; Brexit, 362, 382; Government Communications Headquarters (GCHQ), 191
 United States; quantum patents, 451
 United States Munitions List, 421
 Universal Automatic Computer (UNIVAC), 93
 University of Göttingen, 498
 unmanned aerial vehicle (UAV), 68, 337
- vacuum pump, 489
 VeriQloud Ltd., 289
 Vernam, Gilbert, 191
 Vichnaic, Gerald, 160
 Volkswagen AG, 390
 Vollmar, Roland, 160
 von Braun, Wernher, 55
 von Neumann architecture, 138
 von Neumann, John, 136
- Wang, Jinliu, 384
 weather modification, 344
 Wehner, Stephanie, 298, 299
 Weizenbaum, Joseph, 99
 WeWork, 369
 Wheeler, John, 160, 500
 Wiesner, Stephen, 137
 Williamson, Malcolm, 191
 Wineland, David, 167
 Wirecard AG, 369
 Wootters, William K., 168
- Xanadu Quantum Technologies Inc., 43
- Ye, Jun, 384
 Yoo, John, 422
 Young, Thomas, 491
- Zapata Computing Inc., 411
 Zeigler, Bernard, 160
 Zeilinger, Anton, 298
 Zimmerman, Phil, 271
 Zuse, Konrad, 86, 160, 393