

# Index

- \*.Sat, 25
- 10K clean room, 294
- 1KUNS-PF, 498
- AAUSAT3, 195
- AC-7A, 461
- active antenna, 547
- Active Optics, 823
- Ad hoc NETworks (MANETs), 194
- ADS-B
  - Chengdu, 246–248
  - Lhasa, 247, 248
- ADS-B antenna, 196, 243
- Advanced Multi-Mission Operations System (AMMOS), 147
- AeroCube, 266, 269, 271, 284, 473, 739
  - AeroCube-11P, 471
  - AeroCube-11S, 471
  - AeroCube-7A, 461
  - AeroCube-7B, 460
  - AeroCube-7C, 460
- AeroCube-5, 265
- AeroCube-6, 265–275, 277, 279, 281–285
  - AC6-A, 267–277, 279–281, 284
  - AC6-B, 267, 275–279, 281, 284
- AeroCube-7, 271, 460, 461
- Aerospace Concurrent Engineering Method (CEM), 852
- Aerospace Debris Environment Projection Tool (ADEPT) simulation, 694
- Aerothermodynamics, 601, 603
- AIS, 13, 18, 188, 189, 191, 195, 230, 260, 321–323, 325–327, 329, 331, 333–337, 339–341, 343–347, 349, 351, 353, 395, 411
- AISSAT-1, 189, 321–323, 325, 327, 333, 334, 340–343, 345, 346, 347, 350
- AISSat-2, 322, 325, 333, 334, 340–343, 345, 346, 350
- AISSat-3, 322, 325, 333, 334
- alamarBlue, 47, 51
- Albert Einstein’s revolutionary theory of General Relativity, 812
- ALMA, 361, 363
- Amazon, 137, 207, 685, 705, 730, 798
- Amazon Web Services (AWS), 730
- americium, 831
- Antarctic, 46, 187, 188, 205, 229
- AntiMicrobial satellite, 49
- Arctic, 45, 187, 188, 337
- ARM7, 191, 197, 230, 231, 295, 330
- asteroid exploration, 763
- Astrobiology, 28
- ATLAS LINKS, 591, 592
- atomic layer deposition (ALD), 746
- attitude determination algorithms, 224
- attitude motion model for a rigid body, 223

- attributes of the nested ring unit, 776
- auroral imaging, 3, 276
- Automatic Identification System (AIS), 13, 18, 188, 260, 321, 395
- autonomous fault management, 848
- avalanche photo diode (APD), 460, 517, 526
- Baikonur Cosmodrome, 322, 343, 344
- ballistic coefficients, 266
- barycentric coordinate reference system (BCRS), 817
- BCT NanoSlice Tracker, 145
- BeiDou, 193, 230, 235, 537–539
- beta emission, 832
- bioblock, 47
- bioCDLab, 52–54
- BioExplorer, 28
- biological, 23, 24, 26–32, 36, 51–53, 55, 56, 59, 63, 66, 67, 444, 449, 817
- BION Missions, 27
- Biona-C, 27
- Bionanosatellite, 25, 27
- BIRDS, 15, 493, 503m
- BIRDS-1, 492–493
- BIRDS-2, 493–494, 495, 503
- Blackjack, 443, 444, 452–455, 457
- BMSTU-Sail, 15, 18
- Brane Craft, 733–767
- Delta-v map, 755, 756
- Flexinol®, 752
- shape control, 737, 751
- shape-memory alloys, 752
- solar sailing, 758–767, 868
- BRITE, 325, 351
- buildup of contamination, 853
- burnwire, 269
- business-as-usual” (BAU) model, 694
- Cal Poly, 20, 29, 59, 64, 67, 166
- CAMEO, 784, 807,
- Canadian advanced nanosatellite operating environment (CANOE), 330
- Canberra DSN, 166, 168
- Canadian Advanced Nanosatellite Explorer-2 (CANX-2), 233, 551, 552
- CanX-4, 325, 351
- CanX-5, 325, 352
- Capella Space, 126, 400, 406, 409
- capillary pressure difference, 635
- CASSIOPE, 552
- cellularization, 444, 449, 456
- Ceratopteris richardii*, 55
- CeREs, 9, 755, 758
- CHAMP, 545, 557–558
- CHASQUI, 13
- Cherenkov detectors, 516, 527,
- Chibis-M, 7, 10–13, 16, 21
- Chinese Fengyun 1C weather satellite, 679, 680, 682, 695, 735
- chip-scale atomic clock (CSAC), 800, 808, 838, 862
- CICERO, 9, 555, 559
- circular error probable (CEP), 350
- CLARA, 334, 332, 352
- cloud ice map, 384–385, 389
- cloud radiometer, 356–357, 361, 364–367, 369–373, 377, 387–388
- Cloudera, 705, 730
- cold-gas thruster, 73, 75–76, 78–80, 83, 86, 91, 103–108, 110
- Compact Full-field Ion Detector System (CFIDS), 523–527,
- Compact Total Electron Content Sensor (CTECS), 553, 558
- Concept Design Center (CDC), 266
- concept of operations (CONOPS or ConOps), 116, 367, 368, 777, 815
- constellation, xii, 3–4, 9–10, 14, 20–22, 117, 121, 125, 131, 185,

- 609, 695, 697, 699, 701, 702,  
727, 728, 730, 731, 735, 768,  
804, 848–849, 856, 866–867
- Constrained Application (CoAP)  
protocol, 798–799
- Consultative Committee for Space  
Data Systems (CCSDS), 144,  
147, 154, 205, 568–569, 578  
583, 600
- convolutional neural network  
(CNN), 849
- copper indium gallium selenide  
(CIGS), 779, 802, 804
- coronal mass ejections, 143, 508,  
532, 598, 855–856
- COSMIC, 2, 3, 21–22, 359, 505,  
507–536, 551, 742, 838–839,  
857
- COSMO-Skymed, 421
- cost of capital, 427, 437–438,
- coverage patterns, 414
- CryoCube, 565
- CSSWE, 8, 22,
- CubeSat Antennas, 570v571 ,
- CubeSat Space Protocol (CSP), 187,  
191, 296, 724–725
- CubeSat Standard, 253–254, 260
- Cubli, 772–773, 805
- Cybersecurity policy, 662–665
- Cyclops, 489, 490
- CYGNSS, 542
- “DAPPER” Application-Specific  
Integrated Circuit (ASIC)  
chip, 523
- Deep Space Network (DSN), 144,  
568–569, 838
- Deep-Space Radiation, 56, 150,  
508, 511
- DeepSpace-1, 105
- Defect Formation, 515
- Defense Advanced Research Projects  
Agency (DARPA), 443–457
- DEFIANT, 324
- delay/disruption tolerant  
networking (DTN), 583
- delay-lock loop (DLL), 545
- Dellingr, 8, 11
- Demeter, 10
- Department of Defense Directive  
(DoDD) 3100.10, 657
- development times, 119, 130, 131,  
350
- DICE, 8, 11, 566
- differential drag, 265, 266, 273–275,  
426, 434
- disaggregation, 444, 445, 449, 455
- distributed ACS, 787
- DIWATA-1, 491, 492
- DNEPR, 13, 25, 265, 867
- Docker, 731
- DoDI 8581.01, 662–665, 671
- DSMC, 603, 609, 611, 613, 616,  
617, 623
- DX1, 13
- Dynamic Ionosphere CubeSat  
Experiment (DICE), 566
- E. coli*, 25, 39, 49–51, 66
- Eaglescout, 471
- Earth-Moon L1 Lagrange point  
(EML1), 765
- EcAMSat*, 25, 41, 49, 50, 66
- Einstein ring, 813, 815–817,  
819–821
- electrospray thrusters, 734, 739,  
802, 836
- Elysium Planitia, 174
- Encryption, 32, 289, 319, 663, 664,  
665, 668, 671
- End of Mission Plan (EOMP), 657
- erosion and flake generation, 100
- ESPA Class, 121
- European Centre for Medium-  
Range Weather Forecasts  
(ECMWF) model, 555

- eXCITe, 451  
 Exocube, 8, 9, 11  
 exostar, 813, 836, 850, 851  
 extended Kalman filter (EKF), 329
- F6 technology package (F6TP), 447  
 Falcon 1, 25, 64  
 FAA Policy, 659  
 FASTSAT, 44, 45, 569  
 FCC Policy, 658  
 FFI – Forsvarets  
     Forskningsinstitut, 189, 260,  
     321, 323, 341, 343, 349  
 FIREBIRD, 8, 11  
 flame spectrometer, 605, 608, 617,  
     619, 622  
 FOTON, 552  
 FPGA, 199–201, 240, 260, 271, 333,  
     334, 402, 464, 523, 546, 594,  
     597, 847  
 FreeRTOS, 296  
 French Space Operation Act  
     (FSOA), 677  
 fuzzy inference engine (GFIE), 849
- galactic cosmic rays, 505, 510, 511,  
     742, 855  
 Galassia, 287–290, 292–319,  
     723–725  
 Galileo, 419, 537–539, 605, 681  
 gallium nitride (GaN), 73  
 GAMALINK, 187, 191, 194, 234  
 gamma radiation, 513, 748  
 gamma ray, 12, 13, 508, 511, 513,  
     598, 831  
 GeneBox, 64, 25, 28  
 generative adversarial networks  
     (GANs), 849  
 GeneSat-1, 23–39, 41, 42, 59, 66–68  
 GeoOptics constellation, 555  
 Github, 154, 705, 723  
 Global Monitor and Control Center  
     (GMaCC), 563
- GLONASS, 537–539, 544, 548, 551,  
     681  
 GNB, 327–328, 330, 331, 333, 334  
 GNSS, 7, 9, 18, 537–544, 548–550,  
     554–556  
 Golay 9, 792  
 GOMX-1, 190, 197  
 Google Maps, 704, 706, 708–711,  
     715, 716, 719, 720, 723, 728  
 GPredict, 706, 723  
 GPS, 7, 18, 187, 190, 191, 193–195,  
     197, 201, 205, 206, 208,  
     210–212, 214, 216–218, 230,  
     231, 235, 239, 255, 258, 271,  
     273, 278, 292, 326, 328, 329,  
     364, 367, 374, 395, 405, 419,  
     455, 462, 468, 537–539,  
     541–545, 547–553, 556, 580,  
     681, 692, 80  
 GPS/BD2 receiving antenna, 211  
 GPS/BeiDou receiver, 187, 190, 235  
 GraviSat, 51–55  
 gravitational lens, 811, 812  
 gray (Gy), 46, 49, 511, 512, 742  
 green fluorescent protein, 30  
 ground sampling distance (GSD),  
     197, 421  
 ground-laser beacon, 463  
 GRYPHON, 324, 683
- habitable zones, 811  
 Hadoop Distributed File System  
     (HDFS), 728  
 Hagen–Poiseuille equation, 636  
 Hamlib, 723, 724  
 heat pipe, 633, 633–637, 639,  
     641–644, 646–648  
 heat pipe working fluids, 638  
 heat pipes, 406, 632, 633, 639,  
     640–643  
 heat sinks, 405, 630, 631  
 helical antenna, 240, 243, 246  
 heliophysics, 357, 509, 856, 869

- hierarchical temporal memory (HTM), 849
- high-enthalpy nonequilibrium flow, 602
- HIVE, 771–792, 795–805
  - adaptable, 771, 799, 804
  - carbon fiber-reinforced composites (CFCs), 796
  - cellular biology, 771, 774, 776
  - change of topology/morphology, 772
  - continually upgradeable, 771
  - dynamics simulation library, 792
  - evasive maneuver, 772, 777, 790, 791
  - mass-production, 772
  - sliding contacts, 797
  - space architecture, 771, 773
  - thermal model, 788, 791
  - torques, 777, 781, 782, 785, 787, 788–790, 795, 800
- HIVE aggregate reconfiguring, 773, 794
- HIVE as a series of nested rings, 774
  - core, 774, 775, 778, 780, 781, 785, 792, 794, 797
  - inner trams, 775
- HIVE cellular unit, 773
- HIVE concept attributes, 777
- HIVE as an assembly of cellular automata, 783
- HIVE unit
  - flatpack, 775
- Hodoyoshi-3/4, 75, 79
- Hoshide, 487
- Human Health and Spaceflight, 510
- hyperbolic trajectories, 856
- hyper-integrated satlets (HISats), 450
- I2C bus communication protocol, 31
- ice water path (IWP), 358
- IceCube, 355–389
- Iceye, 400, 406,
- icing, 187
- I-COUPS (Ion thruster and cold-gas thruster Unified Propulsion System), 75
- I-COUPS, 75–82, 86, 89, 92, 100, 101, 103–106, 109–111
- IGOR, 550, 551
- IKAROS, 142, 761, 825
- IlliniSat-2 bus, 617, 619
- image deconvolution, 815, 817, 820, 821
- indium tin oxide (ITO), 738
- infant mortality, 135
- INSPIRE, 143–150, 153–155, 177, 179
- insurance, 418, 430, 435, 436, 438, 439, 661
- Integrated Solar Array Antenna for CubeSat (ISAAC), 574
- Inter-Agency Debris Coordinating Committee (IADC), 677
- International Academy of Astronautics (IAA), 189, 260
- International Association of Lighthouse Authorities (IALA), 335
- international development, 130
- International Space Station (ISS), 9, 12, 24, 119, 333, 356, 402, 461, 477, 501, 508, 561, 598
- International Telecommunication Union (ITU), 660
- Internet of Things (IoT), 395, 417, 703, 774
- intersatellite links (ISL), 415, 575, 584
- ionic polymer-metal composites, 753
- ionosphere, 2, 3, 7, 8, 9, 19, 278, 290, 292, 537, 539, 540, 541, 542, 543, 544, 546, 549, 551, 555, 566

- Irazu, 496, 497  
 ISARA, 472, 473, 573,  
 ISGEN, 28  
 Iskra-MAI-85, 14  
  
 Japan Aerospace Exploration  
   Agency (JAXA), 7, 50, 73, 74,  
   79, 80, 144, 178, 477, 478, 479,  
   481, 482, 483, 484, 485, 486,  
   487, 488, 489, 490, 491, 492,  
   493, 494, 495, 496, 497, 498,  
   499, 500, 501, 502, 825, 868  
 JEM Small Satellite Orbital  
   Deployer (J-SSOD), 477, 479,  
   480, 481, 482, 483, 484, 485,  
   486, 487, 490, 499, 501  
 Joint Global Multi-Nation Birds  
   Satellite, 482  
 JSC, 13, 17, 18  
  
 Kaber, 487, 490  
 Kaber#1, 489,  
 Keldysh Institute of applied  
   mathematics, 18  
 Kibo, xv, 50, 477, 478, 479, 480,  
   481, 482, 483, 484, 485, 487,  
   488, 489, 490, 491, 492, 494,  
   495, 496, 498, 500, 501, 502  
 KiboCUBE, 498, 499, 500  
 Kolibri, 12, 13  
 Kounotori, 477, 478, 482, 485  
 Kubernetes, 731  
  
 Langmuir probe, 3, 8, 334, 335  
 large LEO constellations (LLCs),  
   678, 684, 685, 691, 693, 697,  
   698, 699, 700  
 laser transmitter, 460, 461, 462, 463,  
   465, 466, 467, 468, 471, 472,  
   843, 846  
 lasercom, 462, 467  
   BER, 469, 470, 471, 579, 583, 842  
   crosslinking, 472  
   data/BER, 470  
   Si-APD, 468  
   slew rates, 460, 464, 465  
 launches per year by country,  
   680  
 LEO CubeSat Ka-Band Data  
   Rate/Link Margin, 580  
 LEO Nanosatellite Data Rates,  
   567  
 LEO Radiation Environment, 279,  
   282, 284  
 LEON-3, 150  
 LiCoO<sub>2</sub> chemistry, 399  
 LIDAR, 550, 781  
 linear energy transfer (LET)  
   detectors, 59, 516, 518, 519,  
   520, 522, 523, 524, 528, 530,  
   838  
 local time of ascending node  
   (LTAN), 434  
 Low-Mass Radio Science  
   Transponder (LMRST), 144  
  
 machine learning model, 615  
 machine-to-machine (M2M), 413,  
   416, 417, 418  
 Magion-4, 5, 5, 6  
 Maglev trains, 781  
 MANET, 194, 799,  
   A-MANET, 799  
 MarCO, 57, 141, 143, 148, 149, 150,  
   151, 152, 153, 154, 155, 156,  
   157, 158, 159, 160, 161, 165,  
   166, 167, 168, 169, 170, 171,  
   172, 173, 174, 176, 177, 178,  
   179, 573  
   MarCO-A, 160, 161, 162, 163,  
   165, 166, 167, 169, 170, 172,  
   173, 175  
   MarCO-B, 160, 161, 162, 163,  
   164, 165, 166, 168, 169, 170,  
   172, 173, 174, 175, 176, 178  
   MarCO CDH, 155, 177

- marine/air traffic information, 186, 256
- master oscillator power amplifier (MOPA), 461 Mayak
- Mayak, 14
- MCubed/COVE-2, 402
- MEAN, 706
- MEMS, xx, 145, 187, 190, 193, 194, 219, 221, 230, 251, 258, 271, 293, 317, 405, 528, 610, 611, 737, 847, 867
- MEMS gyro, 145, 193, 218, 251, 258, 293, 317, 847
- MERRA-2, 372
- MeteorJS, 706, 723, 724, 728
- micro water heat pipes, 633
- microchip PIC, 270
- microdosimeters, 266
- micro-electrospray thrusters, 739
- MicroPirani, 608, 611, 612
- MicroSat, 36, 118, 123, 126, 131, 406, 407, 418, 425, 434, 440, 487, 489, 490
- MIEM, 15, 18
- MIL-STD-1540C, 306
- miniature ion propulsion system (MIPS), 75, 76, 79, 197, 294, 737, 738, 749
- Miniature X-ray Solar Spectrometer-1 (MinXSS-1), 376, 388
- MiRaTA mission, 548, 552
- Mission category summary, 124
- MKA-N, 13, 18
- model-based systems engineering (MBSE), 784, 785, 786
- modern web technologies, 708
- Modis, 250, 205, 208, 209
- Modular, Integrated Nanosatellite Rideshare Adapter System (MINRAS), 59, 60
- MongoDB, 706, 728
- monitor the moon from low lunar orbit, 765
- Monitor-Analyzer-Planner-Executive (MAPE), 849
- MSPA and Opportunistic MSPA (OMSPA) downlink telemetry, 586, 589, 590, 591
- MTF lens, 202, 203
- multi-layer insulation (MLI), 32, 35, 481, 482, 632,
- Multi-Mission Radioisotope Thermoelectric Generator (MMRTG), 831
- multiple spacecraft per aperture (MSPA), 161, 162, 174, 586, 587, 589, 590, 591
- Multispectral Observation System (CUMULOS), 472
- nano-electrospray thrusters, 734, 739, 741
- nanokite, 46, 47
- NanoRacks, 50, 65, 130, 365, 367, 487, 562
- NanoSail D1, 25, 41, 42, 43, 44, 45
- NanoSail D2, 25, 41, 43, 44, 45, 761
- NanoSat, 13, 14, 64, 65, 118, 123, 126, 131, 288, 393, 394, 395, 396, 397, 398, 399, 400, 401, 403, 404, 405, 405, 407, 418, 425, 543, 546, 551, 552, 553, 554, 555, 556, 566, 569, 574, 575, 576, 577, 578, 580, 581, 582, 584, 585, 586, 588, 598, 678, 683, 684, 695, 696, 697, 699
- NanoSat Missions, 393, 394, 397, 399, 402, 407, 554, 555, 556, 578, 580, 581, 598
- NanoSat Transceiver, 569
- Nanosatellite Launch Adapter System (NLAS), 59, 60, 61, 64, 65
- NanoSense FSS-4, 222

- NASA  
 NextSTEP, 148  
 SIMPLEX, 148  
 NASA Ames Early Biological  
 Science, xi, 26, 27, 28, 46, 51,  
 63, 64, 66, 67, 605, 849  
 NASA Innovative Advanced  
 Concepts (NIAC), 733, 766,  
 767, 810, 814, 816, 853, 856  
 National Commercial and Space  
 Programs Act, 666  
 National Telecommunications and  
 Information Administration  
 (NTIA), 65, 563, 565, 567, 578,  
 660, 661, 662, 671,  
 NAVIC, 537, 538, 539  
 navigation radar detector (NRD),  
 346, 348, 349, 350,  
 NCube-1, 189  
 NCube-2, 189  
 Near Earth Network (NEN), 561,  
 562, 563, 564, 565, 567, 568,  
 569, 573, 574, 575, 576, 577,  
 578, 579, 580, 581, 583, 587,  
 588, 589, 590, 591, 593, 596,  
 597, 598  
 Near-Earth Object Human Space  
 Accessible Targets Study  
 (NHATS), 764  
 near-Earth plasmas, 2  
 NEAScout, 148, 150  
 NEMO, 324, 325, 331, 332, 334,  
 337, 348  
 NEN Frequencies, 565  
 NEQAIR, 617, 623,  
 networked spacecraft, 447, 849  
 Networks Integration Management  
 Office (NIMO), 597  
 neural network, 617  
 NFIRE, 460  
 NICER, 839  
 NIST SP 800-59 checklist, 663, 665  
 nitinol wire, 269  
 nitric oxide NO, 617  
 NOAA, 386, 563, 657, 658, 664,  
 666, 667, 673, 707  
 NOAA Commercial Remote  
 Sensing Regulatory Affairs  
 (CRSRA) website, 666  
 NORAD, 217  
 NORAIS, 333, 334, 341, 346,  
 NorSat-1, 322, 325, 331, 332, 334,  
 335, 344, 345, 346, 347, 348,  
 350  
 NorSat-2, 322, 325, 331, 332, 335,  
 336, 337, 339, 344, 345, 346,  
 348, 350  
 Northern Sea routes, 187  
 NovAtel receivers, 546, 551, 552,  
 554, 555, 563  
 NovaWurks, 449, 450  
 NPS CubeSat Launcher, 59  
 NUS Satellite and Airborne Radar  
 Systems Laboratory (SARSL),  
 301, 307  
 observing line-of-sight (LOS), 540  
 OneWeb, 137–138, 444, 677–678,  
 685, 697  
 OPALS (*see Optical Payload for  
 Lasercomm Science*), 460  
 open loop, 146, 461, 468, 473, 545,  
 546, 547, 549, 556, 587, 590  
 Open Systems Interconnection  
 (OSI), 447, 585  
 OPIR (*see overhead persistent  
 infrared*), 455  
 optical communication, 142, 455,  
 459–461, 473, 775, 816, 867  
 Optical Communications and Sensor  
 Demonstration (OCSD), 271,  
 460–461, 471–473, 742, 847  
 Optical Payload for Lasercomm  
 Science (OPALS), 460  
 Orbital Debris Assessment Report  
 (ODAR), 657, 658, 659

- Orbital Debris Mitigation Standard Practices (ODMSP), 657–661, 673, 677–678, 684, 694, 700
- OSIRIS, 460, 552
- Oumuamua, 758, 856
- Outer Space Treaty of 1967, 652  
parent agency of the satellite, 653, 654
- overhead persistent infrared (OPIR), 455
- Parker Solar Probe, 829
- Parus, 682
- Payload Orbital Delivery System (PODS), 450, 451
- peak power tracking (PPT), 330
- Perseus, 13, 18, 126
- PharmaSat, 25, 36, 37, 38, 39, 40, 41, 42, 43, 45, 47, 49, 50, 54, 59, 66
- phase-lock loop (PLL), 545
- PhoneSat, 61, 62,
- Physical Meteorological Observatory Davos and World Radiation Center (PMOD/WRC), 335, 336, 350
- PicoSat, 19, 118, 123, 131
- PicoSatellite Solar Cell Testbed (PSSCT), 553, 867
- Pit Boss, 454
- Planet Labs, xiii, 123, 125, 127, 129, 137, 186, 403, 488, 561,
- Planetary Defense, 734, 765, 767, 856
- Plotly, 707, 725, 728
- PODSat, 450
- Polar Satellite Launch Vehicle (PSLV), 288
- policy compliance, 651, 653, 654, 659, 660, 663, 665
- policy compliance process, 659, 660, 663, 666, 667
- policy roadmap flowchart for NASA satellites, 671
- policy roadmap flowchart for private satellites, 672
- polycyclic aromatic hydrocarbon (PAH), 48
- Poly Picosatellite Orbital Deployer (P-POD), 29, 31, 36, 44, 45, 59, 60, 63, 64, 65, 118, 193, 228, 311
- PRESat, 25, 36, 41, 42, 45
- probability-severity (P-S) metric, 686
- protos, 144
- proximity-operations policy, 667
- PSLV, 288, 299, 310, 311, 312, 319, 320
- PSSCT-2, 552, 553, 867
- Pyxis receiver, 555
- quantum key distribution (QKD), 289, 315, 319
- QualNet, 585
- quasi-Euler angles, 227
- Quasi-Zenith Satellite System (QZSS), 537, 538, 539
- radiation damage, 232, 505, 513, 514, 515, 517, 519
- radiation dose, 48, 511, 742, 743, 748, 749, 754, 755, 763  
gray, 46, 49, 511, 512, 742  
sievert, 511
- radiation-belt particles, 275, 276
- radiation-tolerant ZnO, NONE
- radiators, 405, 406, 632, 792, 804
- radio occultation (RO), 9, 537, 540, 542  
delay-lock loop (DLL), 545  
RO receiver, 543, 546, 550, 555  
RO sensor, 537, 542, 543, 546, 547, 550, 551, 552, 553, 554, 555, 556
- radioisotope thermoelectric generator (RTG), 398, 779, 830, 831, 834, 852

- Radio Aurora Explorer (RAX), 11, 144, 155, 179, 569
- Radio Aurora Explorer-2 (RAX-2), 8
- Rayleigh criteria, 425
- recurrent neural networks (RNNs), 849
- re-entry (*also reentry*) flow regimes, 623
- remote sensing, 3, 117, 355, 356, 357, 358, 360, 361, 383, 389, 395, 397, 399, 400, 402, 407, 461, 660, 664, 666
- Resident Space Object (RSO) catalog, 688, 692, 700
- resistance temperature detectors (RTDs), 514
- RESTful, 705, 706
- Roll Out Solar Array (ROSA), 400
- Rossengeorgiev Nite-Overlay, 707, 716, 728
- SAC-C GPS, 545
- SamSat, 13,
- SAR Lupe, 421
- SAR NanoSat, 404, 406
- satellite-based augmentation system (SBAS), 538
- satellite mass and size, 121, 122
- SBAS, *see also satellite-based augmentation system*, 538
- Science* magazine, 186
- SeaHawk 1, 565
- semi-autonomous reconfiguration, 446
- shape-memory alloy, 60, 267, 269, 752, 767
- SHERPA, 451
- SHIELDSE-2 model, 743
- Simplified General Perturbations Satellite Orbit Model 4 (SGP4), 217, 709, 723
- sievert (Sv), 511
- Small Photon-Entangling Quantum System (SPEQS), 289, 290, 291, 292, 293, 294, 295, 297, 306, 314, 315, 317, 318, 319
- software-defined radio (SDR), 144, 194, 195, 333, 334, 336, 546, 547, 552, 556, 580
- Sol 2.0, 813
- solar energetic proton (SEP), 505, 508, 510, 513, 519, 531
- solar gravity lens (SGL), 809, 810, 812–827, 829, 831, 832, 834–836, 838, 839, 844–848, 850–853, 855–858
- concept of operations (CONOPS), 116, 283, 367, 368, 777, 815, 818, 824, 829, 847, 852, 853, 857
- ensemble of small spacecraft, 825
- foldable optics, 823
- imaging with the SGL, 819, 821, 822, 823
- laser link budgets, 844, 845
- life indicators, 815
- mission architecture, 67, 814–818, 823–825, 851
- navigation and guidance concepts, 816
- solar sail, 41–44, 64, 142, 745, 759–763, 816, 823, 825–828, 830, 835, 852, 853, 856, 857, 868, 869, 760–762
- spacecraft and CONOPS that are agnostics to the target star system, 818
- string-of-pearls architecture, 815, 824, 838, 852, 857
- Solar Proton Anisotropy and Galactic Cosmic Ray High

- Energy Transport Instrument (SPAGHETI), 519
- solar sailing, xxii, 758–763, 767, 868
- solar wind, 2, 3, 4, 146, 505, 508, 509, 510
- solar wobble, 836, 837
- solid-state space radiation detectors, 516, 517
- sailing on light with interplanetary science and engineering (SolWise), 142, 179
- SOTA, 460
- Space Communications and Navigation (SCaN), 568
- SPace ENVironment Information System (SPENVIS), 742, 753
- Space Fence, 692–694, 698, 700
- Space Launch System (SLS), 56, 148, 565
- space traffic management, 677, 678, 687, 689, 690, 694, 735
- space vehicle ownership, 656
- space weather, 2, 56, 59, 125, 265, 279, 284, 506, 507, 529, 530, 531, 556, 710, 735
- spacecraft “fractionation”, 443
- SpaceCube Mini, 402
- SpaceSeer, 704, 706, 707, 708, 709, 716, 723, 724, 725, 727, 729, 730, 731
- ground station web application, 704
- Node Package Manager (NPM), 706
- Web technology, 705
- SpaceX, 55, 122, 135, 137, 138, 444, 451, 477, 486, 492, 494, 496, 498, 677, 678, 684, 685, 686, 687, 691, 693, 697, 703
- SpaceX Falcon 1, 42, 43
- SPAGHETI, *see also Solar Proton Anistropy and Galactic Cosmic Ray High Energy Transport Instrument*, 519, 520, 521, 522, 523, 530, 531
- spatially separated dosimeters, 265
- SPENVIS, 742, 753
- spin stabilization, 266, 368
- SporeSat, 51, 53, 54, 55, 56
- SporeSat-1, 25, 50, 53, 54, 55, 66
- SporeSat-2, 54, 55, 56, 66
- SQLite format, 725
- StarLink, 138, 444, 866, 867
- STIM-210, 464
- Stirling Radioisotope Generator (ASRG), 832
- STU-2, 186, 188, 189, 190, 191, 218, 233, 235, 256, 257, 258, 259
- STU-2A, 190, 191, 192, 193, 195, 197, 198, 205, 207, 208, 209, 210, 218, 219, 220, 221, 223, 224, 225, 227, 229, 230, 231, 232, 233, 235, 237, 268, 239, 250, 252, 255
- STU-2B, 191, 195, 197, 250
- STU-2C, 190, 195, 196, 205, 208, 211, 212, 213, 215, 217, 218, 229, 230, 231, 232, 233, 237, 238, 239, 240, 243, 244, 245, 246, 248, 250, 255
- Submillimeter-wave Imaging Radiometer (CoSSIR), 358, 360, 361, 363
- Sun’s gravitational field, 810, 812, 818
- SunTower, 802
- supercapacitors, 401, 402, 632
- surface tension, 634, 635
- Svalbard, Norway, 340, 341
- System F6, 443, 445, 446, 455
- system design review (SDR), 294, 295
- Tanyusha 1, 14
- Tatyana-1, 12, 13

- Taylor cone, 739  
TBALL, 166  
TechEdSat, 25, 61  
TechEdSat-8, 62, 565  
TECU, 290, 292, 542  
TelesatLEO, 444  
temporal resolution, 5, 8, 419, 420, 424, 550  
thermal control, 31, 33, 35, 42, 50, 55, 150, 191, 193, 250, 327, 328, 332, 367, 388, 394, 395, 405, 406, 481, 629, 632, 643, 648, 733, 742, 744, 834, 848  
thermal design, 416, 442, 624  
thermal vacuum (TVAC), 80, 81, 110, 119, 147, 156, 236, 257, 305, 306, 307, 365, 366, 380, 381, 387, 618  
thin-film transistors (TFTs), 737, 738, 745, 746  
THUNDER, 324  
Tibet, 247  
TNS-0, 13, 17  
    TNS-#1, 17  
    TNS-#2, 13, 17, 18  
total cost, 412, 414, 427  
total ionizing dose (TID), 46, 49, 57, 59, 143, 742, 743, 753, 763, 766  
Trabant, 12  
tracking aids, 692, 699, 700  
tracking improvements, 691  
trams with payloads, 782  
TRAPPIST-1, 829  
TRIAD, 224  
triple junction solar cells, 32, 193, 232, 332, 462, 619  
tritium, 832  
Tsukuba Space Center, 487, 488, 490, 491, 494, 498  
TurboRogue, 550  
U.S. National Space Policy (NSP), 652, 655, 656  
U.S. Neurolab Biotelemetry, 27  
U.S. Orbital Debris Mitigation Standard Practices (ODMSP), 657, 658, 659, 660, 661, 673, 677, 678, 684, 694, 700  
UBAKUSAT, 494, 495, 496  
Uchinoura, 74  
UHF antenna, 145, 149, 152, 155, 160, 165, 167, 196, 250, 300, 301, 308, 340, 341, 723  
UK-DMC, 542  
Ultem, 34  
UNITEC-1, 142  
United Nations (UN) Specialized Agency responsible for telecommunications, 660  
United Nations Office for Outer Space Affairs (UNOOSA), 479, 496, 498, 500  
Universal Asynchronous Receiver/Transmitter (UART) interface, 143, 201, 220, 235, 289, 295  
universal software radio peripherals (USRPs), 316, 723  
unscented Kalman filter (UKF), 218  
Usuda, 74  
UTE-UESOR, 14  
Van Allen Probes, 4, 277  
Vardø, Norway, 339, 340  
variable emissivity coatings, 633  
VDES, xii, 332, 335, 336, 337, 338, 339, 354, 346  
vector network analyzer (VNA), 358, 360  
VELOX-CI mission, 552  
very long baseline interferometry (VLBI), 73  
WBG detectors, 518, 519, 526, 528  
wetting liquid, 633, 634  
whip antennas, 269

wide bandgap (WBG)  
semiconductors, 505, 517, 519,  
523, 524, 526, 527, 530, 832

Xian Institute of Optics and  
Precision Mechanics, 194

XPNAV-1, 839

XueRong icebreaking, 187

Yagi, 35, 337, 339, 341, 344

Yareelo, 15, 18

Yb-fiber, 461, 466