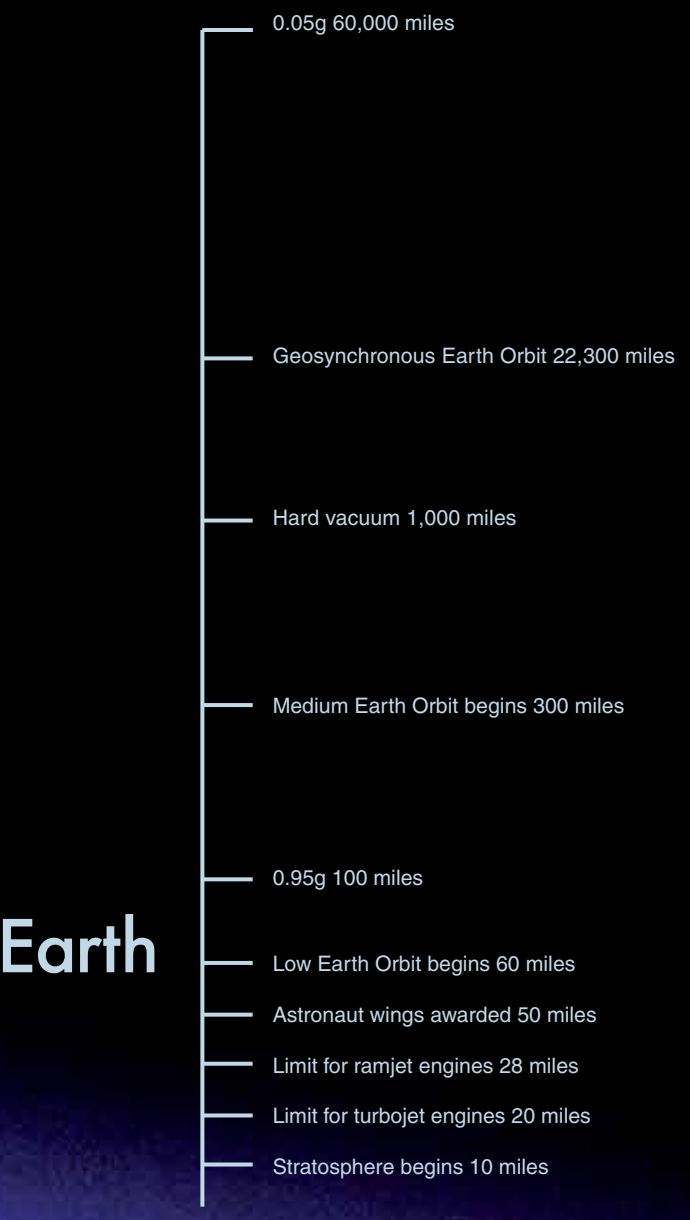
Space Almanac

Space Almanac 1999



Compiled by Tamar A. Mehuron, Associate Editor

On the following pages appears a variety of information and statistical material about space—particularly military activity in space. This almanac was compiled by the staff of *Air Force* Magazine, with assistance and information from R.W. Sturdevant, Air Force Space Command History Office; Tina Thompson, editor of *TRW Space Log;* Phillip S. Clark, Molniya Space Consultancy, Whitton, UK; Joseph J. Burger, Space Analysis and Research, Inc.; and Air Force Space Command Public Affairs Office. Figures that appear in this section will not always agree because of different cutoff dates, rounding, or different methods of reporting. The information is intended to illustrate trends in space activity.

Space facts from NASA public affairs.

Introduction

What's Up There

As of May 26, 1999

Country/Organization	Satellites	Space Probes	Debris	Total
USA	715	45	3,148	3,908
CIS (Russia/former USSR)	1,338	35	2,586	3,959
Iridium	86	0	0	86
Japan	65	4	51	120
Intl. Telecom Sat. Org.	56	0	0	56
France	30	0	16	46
Orbcomm	28	0	0	28
People's Republic of China	26	0	102	128
European Space Agency	24	2	216	242
Globalstar	20	0	0	20
India	19	0	5	24
United Kingdom	18	0	1	19
Canada	15	0	1	16
European Telecom Sat. Org.	15	0	0	15
Germany	15	2	1	18
Intl. Maritime	9	0	0	9
Italy	8	0	3	11
Brazil	8	0	0	8
Indonesia	8	0	0	8
Luxembourg	8	0	0	8
NATO	8	0	0	8
Sweden	8	0	0	8
Arab Sat. Comm. Org.	7	0	0	7
Australia	7	0	2	9
Argentina	6	0	0	6
Mexico	6	0	0	6
South Korea	5	0	0	5
Spain	5	0	0	5
Czech Republic	4	0	0	4
Thailand	4	0	0	4
Asia Sat. Corp.	3	0	0	3
France/Germany	3	0	0	3
Israel	3	0	0	3
Norway	3	0	0	3
Malaysia	2	0	0	2
Philippines	2	0	0	2
Turkey	2	0	0	2
Chile	1	0	0	1
Denmark	1	0	0	1
Egypt	1	0	0	1
Intl. Space Station	1	1	0	2
Portugal	1	0	0	1
Republic of China (Taiwan)	1	0	0	1
SEAL (SEAL Launch Demo)	1	0	1	2
STCT (Singapore/Taiwan)	1	0	1	2
South Africa	1	0	0	1
Total	2,598	89	6,134	8,821

In space, astronauts use a special wind-up shaver that contains a vacuum device to suck up cut whiskers, which could float about and possibly harm spacecraft equipment.

US astronaut Shannon Lucid, who spent 188 days aboard the Soviet space station Mir, is the US spaceflight duration record holder and the world's female record holder.

US space shuttle cockpits are equipped with special "wicket tabs," devices that help astronauts feel and activate controls if their vision becomes temporarily blurred from acceleration or deceleration forces during launch or re-entry.

The Vehicle Assembly Building at the Kennedy Space Center, Fla., is one of the largest buildings in the world—525 feet tall, 716 feet long, and 518 feet wide, with nearly twice the cubic footage of the Pentagon.

Worldwide Launches by Site, 1957–98

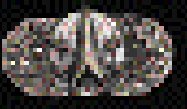
Launch Site	Nation	Launches
Plesetsk	Russia	1,452
White Sands Missile Range, N.M.	US	1,112
Tyuratam/Baikonur	Kazakhstan	1,035
Vandenberg AFB, Calif.	US	538
Cape Canaveral AS, Fla.	US	540
Poker Flat Research Range, Alaska	US	274
JFK Space Center, Fla.	US	112
Kapustin Yar	Russia	83
Kourou	French Guiana	113
Tanegashima	Japan	30
Shuang Cheng-tzu/Jiuquan	China	23
Wallops Flight Facility, Va.	US	26
Uchinoura	Japan	23
Xichang	China	25
Indian Ocean Platform	Kenya	9
Sriharikota	India	8
Edwards AFB, Calif.	US	5
Hammaguir	Algeria	4
Taiyuan	China	8
Yavne	Israel	3
Woomera	Australia	2
Svobodny	Russia	2
Gando AFB, Canary Islands	Spain	1
Barents Sea	Russia	1
Total		**5,429**

Space on the Web

(Some of the space-related sites on the World Wide Web)

Defense	***Web address***
US Space Command	www.spacecom.af.mil/usspace
Air Force Space Command	www.spacecom.af.mil/hqafspc
21st Space Wing	www.spacecom.af.mil/21sw
30th Space Wing	www.vafb.af.mil
45th Space Wing	www.pafb.af.mil
50th Space Wing	www.schriever.af.mil
Industry	
Boeing Space Systems	www.boeing.com/defense-space/space
Hughes Space & Communications	www.hughespace.com
Lockheed Martin Astronautics *(Click "Cosmic Classroom")*	www.ast.lmco.com
Orbital Sciences	www.orbital.com
Rotary Rocket	www.rotaryrocket.com
Space Systems Loral	www.ssloral.com
TRW	www.trw.com/seg/products.html
NASA	
Integrated Launch Manifest *(Launch forecast for shuttle and NASA payloads on ELVs)*	www-pao.ksc.nasa.gov/kscpao/schedule/mixfleet.htm
Jet Propulsion Laboratory Mission and Spacecraft Library	msl.jpl.nasa.gov/home
Mars Global Surveyor	mars.jpl.nasa.gov/mgs
NASA Human Space Flight	spaceflight.nasa.gov
Upcoming Space Shuttle Launches	www-pao.ksc.nasa.gov/kscpao/schedule/schedule.htm
Other	
European Space Agency	www.esa.int
Florida Today (current and planned space activity)	www.flatoday.com/space

Space and Missile Badges



Space/Missile Badge

Astronaut Pilot*

Missile Badge

Missile Badge with Operations Designator

*The astronaut designator indicates a USAF rated officer qualified to perform duties in space (50 miles and up) and who has completed at least one operational mission. Pilot wings are used here only to illustrate the position of the designator on the wings.

The Year in Space

July 4, 1998
M-5 rocket launches Planet-B Mars probe, renamed Nozomi (Hope) after liftoff from Kagoshima Space Center, making Japan only the third nation after US and Russia to attempt interplanetary voyage.
July 21
Alan B. Shepard Jr., first US astronaut into space (May 5, 1961) and one of only 12 humans to walk on the moon, dies of leukemia at age 74.
Aug. 12
Titan IVA booster carrying National Reconnaissance Office (NRO) payload breaks apart and explodes about 40 seconds after launch, which results in six-month suspension of all Titan IV and Titan II launches.
Aug. 26
Boeing Delta III booster carrying Pan-AmSat Galaxy X commercial communications satellite fails during inaugural flight.
Aug. 31
North Korea apparently fails in its first attempt to launch satellite, Kwangmyongsong-1, using multistage Taepo Dong 1 rocket.
Oct. 3
Space Technology Experiment (STEX), first in series of low-cost, technology-demonstration satellites to improve overhead intelligence and first NRO mission publicly described before launch, achieves orbit via Taurus booster from Vandenberg AFB, Calif.
Oct. 16
USAF announces its selection of Lockheed Martin and Boeing to build a new series of rockets—the Evolved Expendable Launch Vehicle—replacing the current Delta, Atlas, and Titan fleets. Boeing is to conduct 19 launches and Lockheed Martin nine, using both Cape Canaveral AS, Fla., and Vandenberg. The first launch is scheduled for 2002.
Oct. 24
NASA's Deep Space 1 launches to test 12 breakthrough technologies, including advanced ion propulsion and self-navigation systems, en route to close encounter with asteroid in July 1999.
Oct. 29
Difficulties in assembling the innovative linear aerospike engine delays first flight of X-33 RLV prototype until December.
Oct. 29–Nov. 7
Shuttle *Discovery* returns 77-year-old John Glenn to space 36 years after he became first American to orbit Earth.
Nov. 1
Motorola's Iridium—first Low Earth Orbit (LEO) satellite communications system to use crosslinks—becomes operational, thereby creating worldwide, wireless telephone network.
Nov. 5
Kodiak Launch Complex, Alaska, celebrates its first mission when Orbital Sciences launches USAF's suborbital Atmospheric Interceptor Technology vehicle.
Nov. 16
Air Force space planners request indus-try to examine potential USAF applications of commercial space—Commercial Space Opportunities Study was scheduled for completion in August 1999.
Nov. 17–18
Leonid meteor storm, potentially largest in 32 years, leaves USAF satellites unharmed, but real-time data compiled during the storm may help prepare for the next Leonid meteor trail.
Nov. 20
Russian Proton rocket launches Zarya, first module of International Space Station (ISS).
Dec. 4–15
Shuttle *Endeavor* completes first ISS assembly mission, connecting Unity module to Zarya, and launches USAF research satellite MightySat I to evaluate composite materials, advanced solar cells, and other technologies.
Dec. 8
NASA selects Boeing for a four-year cooperative agreement to develop the first Future-X flight test bed, designed to be flown in both orbital and re-entry regimes. Boeing's proposal includes on-orbit maneuvering and other capabilities specifically sought for military space applications.
Dec. 11
Mars Climate Orbiter launch begins second installment of NASA program to explore Red Planet robotically.
Jan. 3, 1999
Mars Polar Lander, scheduled to fire two Deep Space 2 microprobes for subsurface exploration before itself setting down near Red Planet's southern polar cap, launches atop Delta II from Cape Canaveral.
Jan. 23
NASA's orbiting Compton Gamma Ray Observatory detects beginning of gamma ray burst and alerts astronomers, who capture first live images of this massive energy producing phenomenon.
Jan. 26
Athena 1 rocket launches Republic of China Satellite 1 (ROCSAT 1), Taiwan's first civil spacecraft, from Spaceport Florida Authority pad at Cape Canaveral.
Jan. 27
The Army announces its approval of Kwajalein Missile Range, Marshall Islands, in the Pacific for commercial space launches.
Feb. 4
After two unsuccessful attempts, Russian cosmonauts abandon plans to unfold 25-meter space mirror, Znamya 2.5, designed to reflect sunlight onto dark portions of Earth. Solar and Heliospheric Observatory (SOHO) spacecraft, which had been completely out of NASA engineers' control between June 24 and Sept. 16, 1998, solves longtime mystery and discovers source of high-speed solar wind.
Feb. 23
First Delta II launched from Vandenberg carries Advanced Research and Global Observation Satellite (ARGOS), first satellite controlled at Kirtland AFB, N.M., satellite control facility from launch to first contact, as well as first Danish and South African satellites—Orsted and SUNSAT, respectively.
March 1
NASA's Lewis Research Center is officially renamed John H. Glenn Research Center to honor Ohio's astronaut senator. Rotary Rocket Co. conducts rollout ceremony at Mojave, Calif., for initial prototype of Roton Atmospheric Test Vehicle (ATV), world's first privately financed, reusable, human-piloted spacecraft.
March 27
Inaugural mission of Sea Launch Co., a Boeing venture with Ukraine and Russia, uses Zenit-3SL booster, launched from Odyssey, a converted oil platform floating in Pacific Ocean 1,400 miles south of Hawaii, to send demonstration satellite into orbit.
April 9
Titan IVB/IUS launch vehicle sends 5,000-pound USAF Defense Support Program (DSP) satellite into improper, highly elliptical orbit.
April 15
NASA's Landsat 7 Earth imaging satellite successfully reaches orbit via Delta II launch from Vandenberg.
April 30
USAF mission to launch latest Milstar satellite fails when Titan IVB/Centaur launched from Cape Canaveral places satellite in improper orbit.
May 1
Curt Newport's remotely operated deep-sea rover locates and photographs astronaut Gus Grissom's Liberty Bell 7 capsule, which sank three miles beneath the surface of the Atlantic after splashdown July 21, 1961.
May 4
US space industry experiences fourth booster malfunction in less than a month when Delta III second-stage failure places Orion 3 communications satellite in wrong orbit.
May 18
Spaceport Systems International announces operating capability of its commercial Spaceport Launch Facility at Vandenberg. First satellite launch is set for fall 1999.
May 19
President Clinton orders DoD to investigate causes for costly string of six US launch vehicle failures in less than nine months and to take corrective actions.
May 22
First Titan IVB launched from Vandenberg carries NRO satellite into orbit, giving US space launch program a welcome shot in the arm after series of failures.
May 25
Hubble Space Telescope Key Project Team announces that, after eight years of precise measurement, it has determined universe's rate of expansion, which is essential to determining universe's age and size.
May 27
NASA releases first global, high-resolution, 3-D view of Red Planet as generated by Mars Global Surveyor's Mars Orbiter Laser Altimeter.
June 24
NASA launches Far Ultraviolet Spectroscopic Explorer (FUSE) telescope to discover how primordial elements of universe were created during "Big Bang" and how the cosmos evolved.

Military & Civilian Space Budgets

US Space Funding, Current Dollars

(Millions, as of Sept. 30, 1998)

FY	NASA	DoD	Other	Total
1959	$261	$490	$34	$785
1960	462	561	43	1,066
1961	926	814	69	1,809
1962	1,797	1,298	200	3,295
1963	3,626	1,550	259	5,435
1964	5,016	1,599	216	6,831
1965	5,138	1,574	244	6,956
1966	5,065	1,689	217	6,971
1967	4,830	1,664	216	6,710
1968	4,430	1,922	177	6,529
1969	3,822	2,013	141	5,976
1970	3,547	1,678	115	5,340
1971	3,101	1,512	127	4,740
1972	3,071	1,407	97	4,575
1973	3,093	1,623	109	4,825
1974	2,759	1,766	116	4,641
1975	2,915	1,892	106	4,913
1976	4,074	2,443	143	6,660
1977	3,440	2,412	131	5,983
1978	3,623	2,738	157	6,518
1979	4,030	3,036	177	7,243
1980	4,680	3,848	233	8,761
1981	4,992	4,828	233	10,053
1982	5,528	6,679	311	12,518
1983	6,328	9,019	325	15,672
1984	6,858	10,195	392	17,445
1985	6,925	12,768	580	20,273
1986	7,165	14,126	473	21,764
1987	9,809	16,287	462	26,558
1988	8,322	17,679	737	26,738
1989	10,097	17,906	560	28,563
1990	11,460	15,616	512	27,588
1991	13,046	14,181	697	27,924
1992	13,199	15,023	769	28,991
1993	13,064	14,106	698	27,868
1994	13,022	13,166	601	26,789
1995	12,543	10,644	629	23,816
1996	12,569	11,514	750	24,833
1997	12,457	11,727	728	24,912
1998	12,321	12,359	768	25,448
Total	**$253,411**	**$267,352**	**$13,552**	**$534,315**

US Space Funding, Constant Dollars

(Millions, as of Sept. 30, 1998)

FY	NASA	DoD	Other	Total
1959	$1,266	$2,377	$165	$3,808
1960	2,198	2,669	205	5,072
1961	4,366	3,838	325	8,529
1962	8,350	6,032	929	15,311
1963	16,659	7,121	1,190	24,970
1964	22,777	7,261	981	31,019
1965	23,016	7,051	1,093	31,160
1966	22,315	7,441	956	30,712
1967	20,803	7,167	930	28,900
1968	18,498	8,026	740	27,263
1969	15,373	8,097	568	24,038
1970	13,665	6,464	443	20,572
1971	11,348	5,533	465	17,346
1972	10,688	4,897	338	15,923
1973	10,275	5,392	362	16,029
1974	8,779	5,620	369	14,768
1975	8,650	5,614	315	14,579
1976	10,807	6,489	379	17,675
1977	8,362	5,863	318	14,543
1978	8,448	6,385	366	15,199
1979	8,779	6,613	386	15,778
1980	9,416	7,742	469	17,626
1981	9,223	8,920	430	18,574
1982	9,298	11,234	523	21,054
1983	9,941	14,168	511	24,620
1984	10,298	15,309	589	26,195
1985	10,050	18,530	842	29,422
1986	10,052	19,818	664	30,533
1987	13,381	22,217	630	36,228
1988	11,033	23,439	977	35,449
1989	12,937	22,943	718	36,598
1990	14,088	19,197	629	33,914
1991	15,399	16,738	823	32,960
1992	14,938	17,002	870	32,810
1993	14,405	15,554	770	30,728
1994	14,020	14,175	647	28,841
1995	13,187	11,190	661	25,038
1996	12,960	11,872	773	25,605
1997	12,607	11,868	737	25,211
1998	12,321	12,359	768	25,449
Total	**$484,973**	**$420,223**	**$24,853**	**$930,049**

Figures may not sum due to rounding. NASA totals represent space activities only. "Other" category includes the Departments of Energy, Commerce, Agriculture, Interior, and Transportation; the National Science Foundation; the Environmental Protection Agency; and other agencies. (Note: NSF recalculated its space expeditures since 1980, making them significantly higher than reported in previous years.) Fiscal 1998 figures are preliminary.

NASA Spending on Major Space Missions

FY 2000 Proposal, Current Dollars

Project Office	Millions
Human spaceflight	$5,468.9
Space science	2,196.6
Earth science	1,459.1
Aerospace technology	1,006.5
Mission communications services	406.3
Life and microgravity sciences	256.2
Safety and mission assurance	43.0
Total	**$10,836.6**

Maximum dynamic pressure, or max Q, is the point when dynamic pressures on the shuttle are greatest. It occurs about one minute after liftoff and at an altitude of 33,600 feet.

Ulf Merbold, a West German, was the first foreign citizen to fly in the shuttle. The launch occurred Nov. 28, 1983.

Space Leaders

(As of July 1, 1999)

Commanders in Chief, US Space Command

Gen. Robert T. Herres	Sept. 23, 1985–Feb. 6, 1987
Gen. John L. Piotrowski	Feb. 6, 1987–March 29, 1990
Gen. Donald J. Kutyna	March 29, 1990–June 30, 1992
Gen. Charles A. Horner	June 30, 1992–Sept. 13, 1994
Gen. Joseph W. Ashy	Sept. 13, 1994–Aug. 26, 1996
Gen. Howell M. Estes III	Aug. 26, 1996–Aug. 14, 1998
Gen. Richard B. Myers	Aug. 14, 1998–

Directors, National Reconnaissance Office

Joseph V. Charyk	Sept. 6, 1961–March 1, 1963
Brockway McMillan	March 1, 1963–Oct. 1, 1965
Alexander H. Flax	Oct. 1, 1965–March 11, 1969
John L. McLucas	March 17, 1969–Dec. 20, 1973
James W. Plummer	Dec. 21, 1973–June 28, 1976
Thomas C. Reed	Aug. 9, 1976–April 7, 1977
Hans Mark	Aug. 3, 1977–Oct. 8, 1979
Robert J. Hermann	Oct. 8, 1979–Aug. 2, 1981
Edward C. Aldridge Jr.	Aug. 3, 1981–Dec. 16, 1988
Martin C. Faga	Sept. 26, 1989–March 5, 1993
Jeffrey K. Harris	May 19, 1994–Feb. 26, 1996
Keith R. Hall (acting)	Feb. 27, 1996–March 27, 1997
Keith R. Hall	March 28, 1997–

Directors, NASA

T. Keith Glennan	Aug. 19, 1958–Jan. 20, 1961
James E. Webb	Feb. 14, 1961–Oct. 7, 1968
Thomas O. Paine	March 21, 1969–Sept. 15, 1970
James C. Fletcher	April 27, 1971–May 1, 1977
Robert A. Frosch	June 21, 1977–Jan. 20, 1981
James M. Beggs	July 10, 1981–Dec. 4, 1985
James C. Fletcher	May 12, 1986–April 8, 1989
Richard H. Truly	May 14, 1989–March 31, 1992
Daniel S. Goldin	April 1, 1992–

Commanders, Air Force Space Command

Gen. James V. Hartinger	Sept. 1, 1982–July 30, 1984
Gen. Robert T. Herres	July 30, 1984–Oct. 1, 1986
Maj. Gen. Maurice C. Padden	Oct. 1, 1986–Oct. 29, 1987
Lt. Gen. Donald J. Kutyna	Oct. 29, 1987–March 29, 1990
Lt. Gen. Thomas S. Moorman Jr.	March 29, 1990–March 23, 1992
Gen. Donald J. Kutyna	March 23, 1992–June 30, 1992
Gen. Charles A. Horner	June 30, 1992–Sept. 13, 1994
Gen. Joseph W. Ashy	Sept. 13, 1994–Aug. 26, 1996
Gen. Howell M. Estes III	Aug. 26, 1996–Aug. 14, 1998
Gen. Richard B. Myers	Aug. 14, 1998–

Air Force Space Command Headquarters, Peterson AFB, Colo.

(As of July 1, 1999)

Commander
Gen. Richard B. Myers

- **Space Warfare Center** • Schriever AFB, Colo.
  Commander **Brig. Gen. (sel.) Gary R. Dylewski**
- **14th Air Force** • Hq., Vandenberg AFB, Calif.
  Commander **Maj. Gen. Robert C. Hinson**
  - **21st Space Wing,** Peterson AFB, Colo.
  - **30th Space Wing,** Vandenberg AFB, Calif.
  - **45th Space Wing,** Patrick AFB, Fla.
  - **50th Space Wing,** Schriever AFB, Colo.
- **20th Air Force** • Hq., F.E. Warren AFB, Wyo.
  Commander **Maj. Gen. Thomas H. Neary**
  - **90th Space Wing,** F.E. Warren AFB, Wyo.
  - **91st Space Wing,** Minot AFB, N.D.
  - **341st Space Wing,** Malmstrom AFB, Mont.

z a t i o n s

Major Military Space Commands

	Personnel	Budget, FY2000	Activities
Unified Command US Space Command Peterson AFB, Colo.	851	$42.0 million	Responsible for placing DoD satellites into orbit and operating them; supports unified commands with space-based communications, weather, intelligence information, navigation, and ballistic missile attack warning; enforces space superiority through protection, prevention, negation, and surveillance; ensures freedom of access to and operations in space and denies same to adversaries; applies force from or through space; plans for and executes strategic ballistic missile defense operations; supports NORAD by providing missile warning and space surveillance information; advocates the space and missile warning requirements of the other unified commands.
Service Command Air Force Space Command Peterson AFB, Colo.	33,669	$1.7 billion	Operates military space systems, ground-based missile-warning radars and sensors, missile-warning satellites, national launch centers, and ranges; tracks space debris; operates and maintains the USAF ICBM force (a component of US Strategic Command). Budget includes funding for 11,000 contractor personnel and operations and maintenance for seven bases and 50 worldwide sites.
Naval Space Command Dahlgren, Va.	526	$88.9 million	Operates assigned space systems for surveillance and warning; provides spacecraft telemetry and on-orbit engineering; develops space plans, programs, concepts, and doctrine; advocates naval warfighting requirements in the joint arena. Budget includes funding for nearly 100 contractor personnel and operations and maintenance of headquarters, component commands, and field sites.
Army Space Command Colorado Springs, Colo.	606	$53.2 million	Manages joint tactical use of DSCS through the 1st Satellite Control Battalion; operates the Army Space Support Teams and Army Space Support Cell; operates the Joint Tactical Ground Stations; operates the Army National Missile Defense Element; manages the Army Astronaut Program.

Air Force Space Acquisition Organizations

Air Force Materiel Command • Wright–Patterson AFB, Ohio
Commander **Gen. George T. Babbitt Jr.**

Space and Missile Systems Center • Los Angeles AFB, Calif.
Commander **Lt. Gen. Eugene L. Tattini**

- **Defense Meteorological Satellite SPO**[1]
- **Launch Programs SPO**
- **Advanced Systems SPO**
- **Satellite and Launch Control SPO**
- **Space & Missile Test & Evaluation Directorate, Kirtland AFB, N.M.**

USAF Program Executive Officer for Space
Brent R. Collins

- **MILSATCOM**[3]
- **Launch Systems**
- **Space Based Infrared System**[3]
- **Evolved Expendable Launch Vehicle**[3]
- **ICBM/National Missile Defense**
- **Navstar Global Positioning System JPO**[2]

USAF Mission Area Director for Space & Nuclear Deterrence
Brig. Gen. John L. Clay

[1]System Program Office [2]Joint Program Office [3]Program offices located at Los Angeles AFB, Calif.

National Imagery and Mapping Agency (NIMA)
Headquarters: Bethesda, Md.
Established: Oct. 1, 1996
Director: Army Lt. Gen. James C. King

Mission, Purpose, Operations
Provide timely, relevant, and accurate imagery intelligence and geospatial information to support national security objectives. This DoD–chartered combat support agency is also a member of the Intelligence Community and has been assigned, by statute, important national-level support responsibilities.
Structure
Three principal directorates: Operations, Systems and Technology, and Corporate Affairs.
Major facilities in Virginia, Maryland, Washington, D.C., and Missouri, with the NIMA College located at Ft. Belvoir, Va. Also, customer support teams and technical representatives stationed around the world at major customer locations.
Personnel: Classified

Central Intelligence Agency (CIA) Office of Development and Engineering
Headquarters: Washington, D.C.
Established: 1973
Director: Dennis Fitzgerald

Mission, Purpose, Operations
Develop systems from requirements definition through design, testing, and evaluation to operations. Works with systems not available commercially. Disciplines include laser communications, digital imagery processing, real-time data collection and processing, electro-optics, advanced signal collection, artificial intelligence, advanced antenna design, mass data storage and retrieval, and large systems modeling and simulations. Work includes new concepts and systems upgrades.
Structure: Classified
Personnel: Classified

National Aeronautics and Space Administration (NASA)
Headquarters: Washington, D.C.
Established: 1958
Administrator: Daniel S. Goldin

Mission, Purpose, Operations
Explore and develop space for human enterprise, increase knowledge about Earth and space, and conduct research in space and aeronautics. Operate the space shuttle and lead an international program to build a permanently occupied space station, for which assembly began in 1998. Launch satellites for space science, Earth observations, and a broad range of technology Research and Development. Conduct aeronautical R&D.
Structure
Ten centers around the US: Johnson Space Center, Houston; Marshall Space Flight Center, Huntsville, Ala.; Kennedy Space Center, Fla.; Glenn Research Center, Cleveland; Langley Research Center, Hampton, Va.; Ames Research Center, Mountain View, Calif.; Dryden Flight Research Center, Edwards AFB, Calif.; Stennis Space Center, Bay St. Louis, Miss.; Jet Propulsion Laboratory, Pasadena, Calif.; and Goddard Space Flight Center, Greenbelt, Md.
Personnel
Civilians..... 17,600
Contractors..... 166,000

National Oceanic and Atmospheric Administration (NOAA)
Headquarters: Washington, D.C.
Established: Oct. 3, 1970
Administrator and Undersecretary for Oceans and Atmosphere: D. James Baker

Mission, Purpose, Operations
Provide satellite observations of the global environment by operating a national system of satellites. Explore, map, and chart the global ocean and its resources and describe, monitor, and predict conditions in the atmosphere, ocean, and space environment. Its National Environmental Satellite, Data, and Information Service processes vast quantities of satellite images and data. Its prime customer is NOAA's National Weather Service, which uses satellite information in creating forecasts.
Structure
National Environmental Satellite, Data, and Information Service
National Weather Service
National Ocean Service
National Marine Fisheries Service
Office of Oceanic and Atmospheric Research
NOAA Corps
Office of Sustainable Development and Intergovernmental Affairs
Coastal Ocean Program
Personnel
National Environmental Satellite, Data, and Information Service..... 841
Other NOAA employees..... 12,267
Total 13,108

National Reconnaissance Office (NRO)
Headquarters: Chantilly, Va.
Established: September 1961
Director: Keith R. Hall

Mission, Purpose, Operations
Design, build, and operate reconnaissance satellites to support global information superiority for the US. It has operated hundreds of satellites since it was formed in 1960 and officially recognized in 1961. Responsible for innovative technology; systems engineering; development, acquisition, and operation of space reconnaissance systems; and related intelligence activities. Supports monitoring of arms control agreements, military operations and exercises, natural disasters, environmental issues, and worldwide events of interest to the US.
Structure
NRO is a DoD agency, funded through part of the National Foreign Intelligence Program, known as the National Reconnaissance Program. Both the Secretary of Defense and Director of Central Intelligence have approval of the program. Four offices and four directorates report up to the level of the director. Offices are management services and operations, architectures, assessments, and acquisitions, space launch, and operational support. Directorates are signals intelligence systems acquisition and operations, communications systems acquisition and operations, imagery systems acquisition and operations, and advanced systems and technology.
Personnel
Staffed by CIA (38 percent), USAF (41 percent), Navy/Marines (5 percent), Army (1 percent), and DoD civilians (16 percent). Exact personnel numbers are classified.

National Security Agency (NSA)
Headquarters: Ft. Meade, Md.
Established: 1952
Director: USAF Lt. Gen. Michael V. Hayden

Mission, Purpose, Operations
Protect US communications and produce foreign intelligence information. Tasked with two primary missions: an information systems security mission and a foreign intelligence information mission. To accomplish these missions, the director's responsibilities include: prescribing security principles, doctrines, and procedures for the government; organizing, operating, and managing certain activities and facilities to produce foreign intelligence information; and conducting defensive information operations.
Structure
Established by a Presidential directive in 1952 as a separately organized agency within DoD under the direction, authority, and control of the Secretary of Defense, who serves as the executive agent of the US government for the signals intelligence and communications security activities of the government. A 1984 Presidential directive charged the agency with an additional mission: computer security. An operations security training mission was added in 1988. The Central Security Service was established in 1972 by a Presidential memorandum to provide a more unified cryptological organization within DoD. The NSA director also serves as chief of the CSS.
Personnel: Classified

Other Agencies
The White House Office of Science and Technology Policy; Defense Advanced Research Projects Agency; Ballistic Missile Defense Organization; US Space Command and the component commands of the Air Force, Navy, and Army; NORAD; and the FAA's Office of Commercial Space Transportation.

US Space Launch Sites

Orbital Sites

Cape Canaveral AS, Fla.
Located 28.5° N, 80° W. One of two primary US space launch sites. Handles piloted, lunar, and planetary launches and launches of satellites into geostationary orbit. First US satellite in space, first manned spaceflight, and first flight of a reusable spacecraft all originated here. Scene of more than 3,000 launches since 1950. Tract covers more than 15,000 acres. Cape Canaveral also provides range operations for NASA's shuttle, military, civil, and commercial space launches and military ballistic missile tests.

John F. Kennedy Space Center, Fla.
Located 28° N, 80° W. NASA's primary launch base for the space shuttle. Occupies 140,000 acres of land and water on Merritt Island, adjacent coastal strand, and the Indian and Banana Rivers and Mosquito Lagoon surrounding the center. NASA holdings include 84,031 acres. The Merritt Island location was better suited than nearby Cape Canaveral to serve as a launch site for the Apollo program's 363-foot-tall Saturn V, the largest rocket ever built. With the 1972 completion of the Apollo lunar landing program, KSC's Complex 39 was used to launch four Skylab missions and for the Apollo spacecraft for the Apollo–Soyuz Test Project. In the mid- to late 1970s, the Kennedy facilities were modified to accommodate the space shuttle program.

Vandenberg AFB, Calif.
Located 35° N, 121° W. Second of two primary US launch sites. Used for satellites (mostly weather, remote sensing, navigation, communications, and reconnaissance) that must go into polar orbits. Provides basic support for R&D tests for DoD, USAF, and NASA space, ballistic missile, and aeronautical systems. Sole site for test launches of USAF ICBM fleet. Furnishes facilities and essential services to more than 60 aerospace contractors on base. Base covers 98,400 acres. Originally Army's Camp Cooke, turned over to the Air Force January 1957. Renamed Vandenberg AFB Oct. 4, 1958.

Wallops Flight Facility, Va.
Located 38° N, 76° W. Founded in 1945 on Wallops Island, Va. One of the oldest launch sites in the world. First research rocket launched July 4, 1945. Resumed orbital launches in 1995 with the EER Systems Conestoga rocket. From 1961 to 1985, 21 satellites were placed in orbit from Wallops using the Scout vehicle. Wallops currently serves as the East Coast launch site for Orbital Sciences' Pegasus missions. Additional small launch vehicles are expected to be launched from Wallops with the establishment of the Virginia Space Flight Center. Site for launches of NASA's suborbital sounding rockets and the like. Conducts about 15 suborbital launches per year. Covers 6,166 acres on Virginia's eastern shore.

Spaceport Florida Authority
Located 28.5° N, 80° W. State-operated commercial launch sites at Cape Canaveral AS. Launch Complexes 20 and 46 converted to handle small-to-medium-class commercial launch vehicles, boosting satellites into equatorial orbit. Lockheed Martin launched NASA's Lunar Prospector on Jan. 6, 1998, aboard their Athena II and ROCSAT-1 on Jan. 26, 1999, aboard their Athena I. LC 20 is designed for Quick Reaction Program activities and suborbital missions involving Litestar vehicles.

Spaceport Systems Intl. Commercial Spaceport
Located 34.33° N, 120.37° W. Designed to handle polar and near-polar LEO launches. Located adjacent to Vandenberg AFB, Calif. SSI, a limited partnership formed by ITT and California Commercial Spaceport, Inc., declared the facility fully operational in May 1999. Provides both payload processing and launch facilities. Launch complex is capable of handling a variety of small-to-medium launch vehicles, and the payload processing facility can handle small and heavy satellites. SSI has ongoing commercial, NASA, and Air Force contracts for both payload processing and launch.

Alaska Spaceport
Located 57.5° N, 153° W. Designed for polar and near-polar launches, the dual-use commercial launch facility is sited on 3,100 acres at Kodiak Island, Alaska. With funding secured by the Alaska Aerospace Development Corp., Alaska's spaceport authority, construction for the Kodiak Launch Complex is scheduled for completion by November 1999. Upon completion, KLC will be the only non-federally run commercial launch range in the US. KLC will launch payloads up to 8,000 pounds into polar LEO, primarily communications, remote sensing, and scientific satellites. The KLC is designed for all indoor processing of the payload and launch vehicle.

Virginia Space Flight Center
Located 38° N, 76° W. NASA and the Commonwealth of Virginia reached an agreement in March 1997 for the establishment of a Virginia Spaceport on the south end of Wallops Island. Construction of the commercial launch facility began in 1998. The flight center can currently accommodate some small ELVs using up to a Castor 120 power plant at the EER Systems launch tower located on the island, in addition to payload processing. When fully operational, the flight center is expected to be able to handle launch vehicles up to the Athena III.

Suborbital Sites

Poker Flat Research Range, Alaska
Located 65° N, 147° W. Owned by the University of Alaska. Established 1968. Operated by the Geophysical Institute under contract to NASA's Goddard Space Flight Center, Wallops Flight Facility. Only US launch facility currently in polar region. World's largest land-based range. Payload recovery and observatories in flight zone extending north 600 kilometers to coast and over Arctic Ocean. Conducts launches primarily to investigate aurora borealis and other middle- to upper-atmosphere phenomena. Site of more than 274 military and civilian launches.

White Sands Missile Range, N.M.
Located 32° N, 106° W. Established July 9, 1945, as White Sands Proving Ground. Site of July 16, 1945, Trinity shot, world's first test of atomic bomb, and of post-war test and experimental flights with captured German V-2 rockets. Scene of Feb. 24, 1949, launch of Bumper rocket, whose second stage achieved altitude of 244 miles—becoming the first man-made object in space. Now used for launches of suborbital sounding rockets. New Mexico is in the process of establishing a spaceport adjacent to White Sands for commercial orbital launches.

Military Functions in Space

Communications
Provide communications from National Command Authorities to Joint Force Commander. Provide communications from JFC to squadron-level commanders. Permit transfer of imagery and situational awareness to tactical operations. Permit rapid transmission of JFC intent, ground force observations, and adaptive planning.

Environmental/Remote Sensing
Use space systems to create topographical, hydrographic, and geological maps and charts and to develop systems of topographic measurement.

Space Environment/Meteorological Support
Operate ground-based systems and direct NOAA on the operations of space-based DMSP weather satellite systems to provide solar/geophysical support to the warfighter. Provide data on worldwide and local weather systems affecting combat operations.

Missile Defense
Employ space assets to support identification, acquisition, tracking, and destruction of ballistic and cruise missiles launched against forward deployed US forces, allied forces, or US territory.

Navigation
Operate GPS network. Enable commanders to determine precise locations of friendly and enemy forces and targets. Permit accurate, timely rendezvous of combat forces. Map minefields and other obstacles.

On-Orbit Support
Track and control satellites, operate their payloads, and disseminate data from them.

Reconnaissance and Surveillance
Identify possible global threats and surveillance of specific activity that might be threatening to US or allied military forces or US territory. Reduce effectiveness of camouflage and decoys. Identify "centers of gravity" in enemy forces. Accurately characterize electronic emissions.

Space Control
Control and exploit space using offensive and defensive measures to ensure that friendly forces can use space capabilities, while denying their use to the enemy. This mission is assigned to USCINCSPACE in the Unified Command Plan.

Spacelift
Oversee satellite and booster preparation and integration. Conduct launch countdown activities. Operate Eastern and Western Ranges to support ballistic and spaceflight missions.

Strategic Early Warning
Operate satellites to give national leaders early warning of all possible strategic events, including launch of ICBMs. Identify launch locations and impact areas. Cue area and point defense systems.

Tactical Warning/Attack Assessment
Discharge the NORAD mission calling for use of all sensors to detect and characterize an attack on US or Canadian territory. US Space Command carries out similar tactical warning in other theaters.

Force Application
US Space Command is identifying potential future roles, missions, and systems which, if authorized by civilian leadership for development and deployment, could attack terrestrial and space targets from space in support of national defense.

Of 152 current NASA astronauts, 87 are in, or retired from, the military—37 Navy, 32 Air Force, nine Marine Corps, six Army, two Naval Reserve, and one Coast Guard.

Of the 293 current and former astronauts, 201 have taken part in a Scouting program, and 40 are Eagle Scouts.

Burning propellants from the shuttle main engines reach a temperature of 6,000 degrees Fahrenheit, which is hotter than the boiling point of iron.

Non-recyclable waste on the International Space Station will be put on either a Russian return vehicle that will burn up on entering Earth's atmosphere or on a US shuttle which will bring it all the way back to Earth for disposal.

In May 1962, NASA crews searched the ocean surface unsuccessfully for three hours before finally finding Scott Carpenter bobbing in his Aurora 7 capsule, which had landed 250 miles off target.

US Military vs. Civilian Launches

(As of Dec. 31, 1998)

Year	Military	Civilian	Total
1957	0	0	0
1958	0	7	7
1959	6	5	11
1960	10	6	16
1961	19	10	29
1962	31	21	52
1963	26	12	38
1964	32	25	57
1965	28	35	63
1966	32	41	73
1967	24	34	58
1968	20	25	45
1969	16	24	40
1970	15	14	29
1971	10	22	32
1972	11	20	31
1973	8	15	23
1974	6	18	24
1975	7	21	28
1976	7	19	26
1977	9	15	24
1978	8	24	32
1979	4	12	16
1980	5	8	13
1981	5	13	18
1982	6	12	18
1983	7	15	22
1984	12	10	22
1985	6	11	17
1986	3	3	6
1987	6	2	8
1988	6	6	12
1989	13	5	18
1990	13	14	27
1991	9	9	18
1992	12	16	28
1993	13	10	23
1994	12	14	26
1995	9	18	27
1996	11	22	33
1997	9	28	37
1998	7	27	34
Total	**493**	**668**	**1,161**

US Satellites in Orbit and Deep Space

(As of Dec. 31, 1998)

Launch Year	Military	NASA & Civilian	Commercial	Total
1958	0	1	0	1
1959	0	4	0	4
1960	2	5	0	7
1961	5	3	0	8
1962	2	9	1	12
1963	8	9	1	18
1964	14	11	0	25
1965	17	18	0	35
1966	15	21	0	36
1967	27	16	0	43
1968	13	13	0	26
1969	15	12	0	27
1970	10	4	0	14
1971	12	3	0	15
1972	8	7	1	16
1973	8	5	0	13
1974	4	4	2	10
1975	5	6	2	13
1976	10	6	6	22
1977	11	4	0	15
1978	14	7	2	23
1979	8	1	2	11
1980	10	1	1	12
1981	5	3	3	11
1982	5	0	6	11
1983	14	4	4	22
1984	15	3	5	23
1985	9	1	4	14
1986	6	1	2	9
1987	10	1	0	11
1988	10	2	4	16
1989	14	3	0	17
1990	23	3	4	30
1991	10	5	2	17
1992	11	4	4	19
1993	13	5	3	21
1994	11	4	5	20
1995	10	5	10	25
1996	15	5	5	25
1997	9	5	66	80
1998	8	10	74	92
Total	**416**	**234**	**219**	**869**

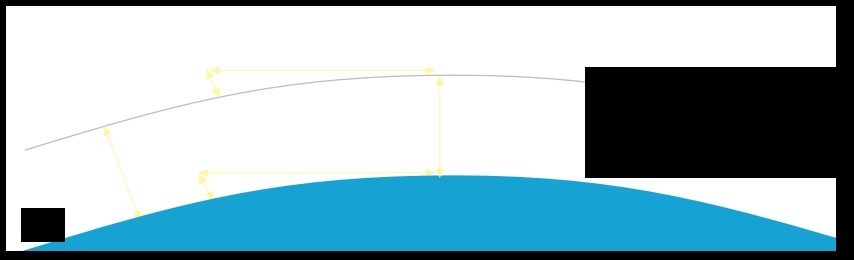
New York has produced 22 astronauts, most of any state. Next is California with 21, and Texas and Ohio, each with 19.

Upcoming Shuttle Flights

Month/Year	Mission	Name
7/1999	**STS-93**	*Columbia*
9/1999	**STS-99**	*Endeavour*
10/1999	**STS-103**	*Discovery*
12/1999	**STS-101**	*Atlantis*
2/2000	**STS-92**	*Discovery*
3/2000	**STS-97**	*Endeavour*
4/2000	**STS-98**	*Atlantis*
6/2000	**STS-102**	*Discovery*
7/2000	**STS-100**	*Endeavour*

Orbits

Orbits result from the mutual attraction of any two bodies with a force proportional to the product of their individual masses and inversely proportional to the square of the distance between them. The curvature of the Earth, on average, drops 16 feet below the horizontal over a distance of about five miles. A spacecraft circling above would "fall" that same amount over the same distance. It travels five miles in one second if gravitational pull equals 1g. Therefore, spacecraft velocity of five miles per second (18,000 mph) produces perpetual orbit at sea level, unless the spacecraft's flight is upset by perturbations, such as solar wind or mechanical anomalies.

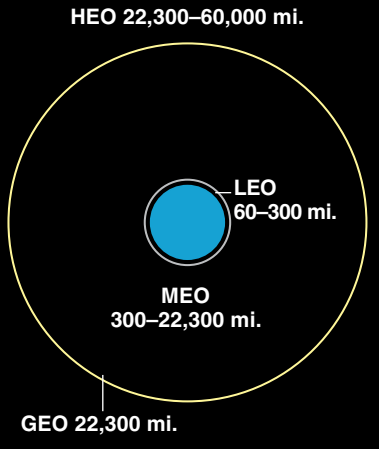


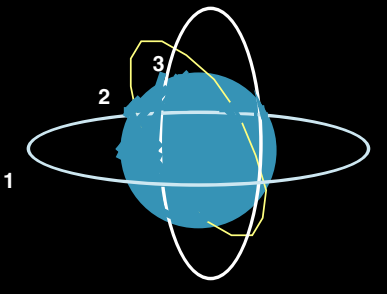
Orbital Altitude

LEO Low Earth Orbit
MEO Medium Earth Orbit
GEO Geosynchronous Earth Orbit
HEO High Earth Orbit

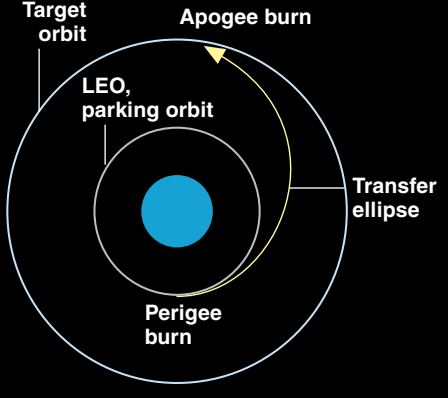
Orbital Inclinations

1 Equatorial
2 Sun synchronous
3 Polar





Geosynchronous Transfer Orbit



It is common procedure to pick an initial "parking" orbit, usually at LEO, then boost payloads to higher altitude. Engines are fired first (at perigee) to reach the apogee of an elliptical transfer orbit and then are fired again to put the spacecraft into a circular orbit at that higher altitude.

Illustrations are not drawn to scale.

US Payloads by Mission, 1957–98

Category	Number
Platforms	**0**
Earth orbital science	**230**
Automated lunar, planetary	**62**
Moon	26
Mercury	1
Venus	8
Mars	12
Outer planets	5
Interplanetary space	10
Applications	**569**
Communications	432
Weather	103
Geodesy	20
Earth resources	12
Materials processing	2
Piloted activities	**163**
Earth orbital	112
Earth orbital (related)	14
Lunar	20
Lunar (related)	17
Launch vehicle tests	**11**
General engineering tests	**61**
Reconnaissance	**431**
Photographic	249
Electronic intelligence	95
Ocean electronic intelligence	39
Early warning	48
Minor military operations	**44**
Navigation	**84**
Theater communication	**0**
Weapons-related activities	**2**
Fractional orbital bombardment	0
Anti-satellite targets	2
Anti-satellite interceptors	0
Other military	**18**
Other civilian	**4**
Total	**1,679**

US Manned Spaceflights

Year	Flights	Persons
1961	2	2
1962	3	3
1963	1	1
1964	0	0
1965	5	10
1966	5	10
1967	0	0
1968	2	6
1969	4	12
1970	1	3
1971	2	6
1972	2	6
1973	3	9
1974	0	0
1975	1	3
1976	0	0
1977	0	0
1978	0	0
1979	0	0
1980	0	0
1981	2	4
1982	3	8
1983	4	20
1984	5	28
1985	9	58
1986	1	7
1987	0	0
1988	2	10
1989	5	25
1990	6	32
1991	6	35
1992	8	53
1993	7	42
1994	7	42
1995	7	42
1996	7	43
1997	8	53
1998	5	33
Total	**123**	**606**

Space Shuttle Flights, 1981–99

(As of June 6, 1999)

Flight	Mission	Launch	Return
1	STS-1	4/12/81	4/14/81
2	STS-2	11/12/81	11/14/81
3	STS-3	3/22/82	3/30/82
4	STS-4	6/27/82	7/4/82
5	STS-5	11/11/82	11/16/82
6	STS-6	4/4/83	4/9/83
7	STS-7	6/18/83	6/24/83
8	STS-8	8/30/83	9/5/83
9	STS-9	11/28/83	12/8/83
10	STS-10	2/3/84	2/11/84
11	STS-11	4/6/84	4/13/84
12	STS-12	8/30/84	9/5/84
13	STS-13	10/5/84	10/13/84
14	STS-14	11/8/84	11/16/84
15	STS-15	1/24/85	1/27/85
16	STS-16	4/12/85	4/19/85
17	STS-17	4/29/85	5/6/85
18	STS-18	6/17/85	6/24/85
19	STS-19	7/29/85	8/6/85
20	STS-20	8/27/85	9/3/85
21	STS-21	10/3/85	10/7/85
22	STS-22	10/30/85	11/6/85
23	STS-23	11/26/85	12/3/85
24	STS-24	1/12/86	1/18/86
25	STS-25	1/28/86	No Landing
26	STS-26	9/29/88	10/3/88
27	STS-27	12/2/88	12/6/88
28	STS-29 (28)	3/13/89	3/18/89
29	STS-30 (29)	5/4/89	5/8/89
30	STS-28 (30)	8/8/89	8/13/89
31	STS-34 (31)	10/18/89	10/23/89
32	STS-33 (32)	11/22/89	11/27/89
33	STS-32 (33)	1/9/90	1/20/90
34	STS-36 (34)	2/28/90	3/4/90
35	STS-31 (35)	4/24/90	4/29/90
36	STS-41 (36)	10/6/90	10/10/90
37	STS-38 (37)	11/15/90	11/20/90
38	STS-35 (38)	12/2/90	12/10/90
39	STS-37 (39)	4/5/91	4/11/91
40	STS-40 (41)	6/5/91	6/14/91
41	STS-43 (42)	8/2/91	8/11/91
42	STS-48 (43)	9/12/91	9/18/91
43	STS-44 (44)	11/24/91	12/1/91
44	STS-39 (40)	4/28/91	5/6/91
45	STS-42 (45)	1/22/92	1/30/92
46	STS-45 (46)	3/24/92	4/2/92
47	STS-49	5/7/92	5/16/92
	STS-50 (48)	6/25/92	7/9/92
	STS-46 (49)	7/31/92	8/8/92
	STS-47 (50)	9/12/92	9/20/92
	STS-52 (51)	10/22/92	11/1/92
	STS-53 (52)	12/2/92	12/9/92
	STS-54 (53)	1/13/93	1/19/93
	STS-56 (54)	4/8/93	4/17/93
	STS-55 (55)	4/26/93	5/6/93
	STS-57 (56)	6/21/93	7/1/93
	STS-51 (57)	9/12/93	9/22/93
	STS-58 (58)	10/18/93	11/1/93
	STS-61 (59)	12/2/93	12/13/93
	STS-60 (60)	2/3/94	2/11/94
	STS-62 (61)	3/4/94	3/18/94
	STS-59 (62)	4/9/94	4/20/94
	STS-65 (63)	7/8/94	7/23/94
	STS-64 (64)	9/9/94	9/20/94
	STS-68 (65)	9/30/94	10/11/94
	STS-66 (66)	11/3/94	11/14/94
	STS-63 (67)	2/3/95	2/11/95
	STS-67 (68)	3/2/95	3/18/95
	STS-71 (69)	6/27/95	7/7/95
	STS-70 (70)	7/13/95	7/22/95
	STS-69 (71)	9/7/95	9/18/95
	STS-73 (72)	10/20/95	11/5/95
	STS-74 (73)	11/12/95	11/20/95
	STS-72 (74)	1/11/96	1/20/96
	STS-75 (75)	2/22/96	3/9/96
	STS-76 (76)	3/22/96	3/31/96
	STS-77 (77)	5/19/96	5/29/96
	STS-78 (78)	6/20/96	7/7/96
	STS-79 (79)	9/16/96	9/26/96
	STS-80 (80)	11/19/96	12/7/96
	STS-81 (81)	1/12/97	1/22/97
	STS-82 (82)	2/11/97	2/21/97
	STS-83 (83)	4/4/97	4/8/97
	STS-84 (84)	5/15/97	5/24/97
	STS-94 (85)	7/1/97	7/17/97
	STS-85 (86)	8/7/97	8/19/97
	STS-86 (87)	9/25/97	10/6/97
	STS-87 (88)	11/19/97	12/5/97
	STS-89 (89)	1/22/98	1/31/98
	STS-90 (90)	4/17/98	5/3/98
	STS-91 (91)	6/2/98	6/12/98
	STS-95 (92)	10/29/98	11/7/98
	STS-88 (93)	12/4/98	12/15/98
	STS-96	5/27/99	6/6/99

Systems & Projects

Major Military Satellite Systems

Advanced Extremely High Frequency Satellite Communications System

Common name: AEHF
In brief: successor to Milstar, AEHF will provide assured strategic, worldwide C^2 communications with five times the capacity of Milstar II but in a smaller, cheaper package
Function: EHF communications
Operator: MILSATCOM JPO (acquisition); AFSPC
First launch: 2006, planned
Constellation: four
Orbit altitude: 22,300 miles
Contractors: Hughes Space and Communications and TRW for engineering model
Power plant: not available
Dimensions: not available
Weight: approx. 5,357 lb (on orbit)

Defense Meteorological Satellite Program

Common name: DMSP
In brief: spacecraft that provide information about cloud cover, atmospheric moisture, temperature, and other phenomena
Function: weather data collection
Operator: NOAA/AFSPC
First launch: circa 1960s
Constellation: two
Orbit altitude: 500 miles
Contractor: Lockheed Martin
Power plant: solar array, 1,000 watts
Dimensions: width 3 ft 11 in, length 20 ft 2 in (with array deployed)
Weight: 1,750 lb (on orbit)

Defense Satellite Communications System III

Common name: DSCS III
In brief: nuclear-hardened and jam-proof spacecraft used to transmit high-priority C^2 messages to battlefield commanders
Function: SHF communications
Operator: AFSPC
First launch: October 1982
Constellation: five
On orbit: 10
Orbit altitude: 22,300 miles
Contractor: Lockheed Martin
Power plant: solar array, avg. 1,269 watts (pre–System Life Enhancement Program); avg. 1,500 watts (SLEP; first SLEP satellite scheduled for launch in 1999)
Dimensions: rectangular body is 6x6x7 ft; 38-ft span (deployed)
Weight: 2,580 lb (pre–SLEP); 2,716 lb (SLEP)

Defense Support Program

Common name: DSP
In brief: early warning spacecraft whose infrared sensors detect heat generated by a missile or booster plume
Function: strategic and tactical missile launch detection
Operator: AFSPC
First launch: November 1970
Constellation: classified
On orbit: classified
Orbit altitude: 22,218 miles
Contractor: TRW
Power plant: solar array, 1,485 watts
Dimensions: width 22 ft (on orbit), length 32.8 ft (on orbit)
Weight: 5,250 lb

Global Broadcast System

Common Name: GBS
In brief: wideband communications program, initially using leased commercial satellites, then military systems, to provide digital multimedia data directly to theater warfighters
Function: high-bandwidth data imagery and video
Operator: AFSPC
First launch: March 1998 (Phase 2 payload)
Constellation: two
On orbit: two
Orbit altitude: 23,230 miles
Contractor: Raytheon (Phase 2)
Power plant: (interim host satellite: UHF Follow-On)
Dimensions: not available
Weight: 3,410 lb

Global Positioning System

Common name: GPS
In brief: constellation of 24 satellites used by military and civilians to determine a precise location anywhere on Earth
Function: worldwide navigation
Operator: AFSPC
First launch: February 1978
Constellation: 24
Orbit altitude: 12,636 miles (Block IIA); 12,532 miles (Block IIR)
Contractors: Boeing, Lockheed Martin, and Loral Fairchild Systems
Power plant: solar array, 700 watts (Block IIA); 1,136 watts (Block IIR)
Dimensions: width 5 ft, length 17.5 ft (deployed) (Block IIA); length 38 ft (deployed) (Block IIR)
Weight: 2,174 lb (Block IIA, on orbit); 2,370 lb (Block IIR, on orbit)

Milstar Satellite Communications System

Common name: Milstar
In brief: joint communications satellite that provides secure, jam-resistant communications for essential wartime needs
Function: EHF communications
Operator: AFSPC
First launch: Feb. 7, 1994
Constellation: four
On orbit: two
Orbit altitude: 22,300 miles
Contractor: Lockheed Martin
Power plant: solar array, almost 5,000 watts
Dimensions: rectangular body length 51 ft (116 ft deployed)
Weight: approx. 10,000 lb

Polar Military Satellite Communications

Common name: Polar MILSATCOM
In brief: USAF deployed a modified Navy EHF payload on a host polar-orbiting satellite to provide an interim solution for a cheaper alternative to Milstar to ensure warfighters have protected polar communications capability
Function: polar communications
Operator: AFSPC
First launch: late 1997
Constellation: three
On orbit: one
Orbit altitude: 25,300 miles (apogee)
Contractor: classified
Power plant: 410 watts consumed by payload (power from host solar array)
Dimensions: numerous items integrated throughout host
Weight: 470 lb (payload)

Space Based Infrared System

Common name: SBIRS
In brief: advanced surveillance system for missile warning, missile defense, battlespace characterization, and technical intelligence. System includes High (satellites in GEO and HEO) and Low (satellites in LEO) components
Function: infrared space surveillance
Operator: AFSPC
First launch: High planned, FY2002; Low, FY2006
Constellation: not available
On orbit: none
Orbit altitude: High at GEO & HEO; Low, LEO
Contractor: Lockheed Martin (High); Low not awarded
Power plant: not available
Dimensions: not available
Weight: not available

UHF Follow-On Satellite

Common name: UFO
In brief: new generation of satellites providing secure, anti-jam communications; replaced FLTSATCOM satellites
Function: UHF and EHF communications
Operator: Navy
First launch: March 25, 1993
Constellation: eight
On orbit: eight
Orbit altitude: 22,300 miles
Contractor: Hughes Space & Communications
Power plant: solar array, 2,500–3,800 watts
Dimensions: length 60 ft (F-2–F-7); 86 ft (F-8–F10) (deployed)
Weight: 2,600–3,400 lb

Wideband Gap-Filler System

Common name: WGS
In brief: high data rate satellite broadcast system meant to bridge the communications gap between current systems—DSCS and GBS—and an advanced wideband system, tentatively scheduled for launch in Fiscal 2008
Function: wideband communications and point-to-point service (Ka-band frequency)
Operator: AFSPC
First launch: FY2004, planned
Constellation: three
Orbit altitude: not available
Contractor: TBD
Power plant: TBD
Dimensions: TBD
Weight: TBD

Dark and Spooky

A number of intelligence satellites are operated by US agencies in cooperation with the military. The missions and, especially, the capabilities are closely guarded secrets. Using a page from the Soviet book on naming satellites, the US government started in the 1980s calling all government satellites "USA" with a sequential number. This allowed them to keep secret the names of satellites which monitor the Earth with radar, optical sensors, and electronic intercept capability. Most of the names of satellites, like White Cloud (ocean reconnaissance), Aquacade (electronic ferret), and Trumpet (Sigint) are essentially open secrets but cannot be confirmed by the Intelligence Community. However, the move to declassify space systems has begun, leading to the release of selected information on some systems. Pictures of the Lacrosse radar imaging satellite have been released without details on the system. Details of the Keyhole optical imaging systems in the Corona program have been released.

Major US Civilian Satellites in Military Use

Advanced Communications Technology Satellite

Common name: ACTS
In brief: technology demonstration satellite for new types of Ka-band communications technologies
Function: communications
Operator: NASA
First launch: Sept. 12, 1993
Constellation: one
Orbit altitude: 22,300 miles
Contractor: Lockheed Martin
Power plant: solar array, 1,400 watts
Dimensions: width 29.9 ft, length 47.1 ft (deployed)
Weight: 3,250 lb

Geostationary Operational Environmental Satellite

Common name: GOES
In brief: hovers over the equator to collect weather data for short-term forecasting.
Function: storm monitoring and tracking, meteorological research
Operator: NOAA
First launch: Oct. 16, 1975 (GOES-1)
Constellation: two
Orbit altitude: 22,300 miles
Contractor: Space Systems/Loral
Power plant: solar array, 1,050 watts
Dimensions: 6.6-ft cube, length 88.6 ft (deployed)
Weight: 4,600 lb

Globalstar

Common name: Globalstar
In brief: mobile communications with provision for security controls
Function: communications
Operator: Globalstar L.P.
First launch: February 1998
Constellation: 48
Orbit altitude: 877 miles
Contractor: Space Systems/Loral
Power plant: solar array, 1,100 watts
Dimensions: width 4.9 ft, length 35.3 ft (deployed)
Weight: 990 lb

Inmarsat

Common name: Inmarsat
In brief: sometimes used for peacetime mobile communications services
Function: communications
Operator: International Maritime Satellite Organization
First launch: February 1982 (first lease), October 1990 (first launch)
Constellation: four
Orbit altitude: 22,300 miles
Contractor: Lockheed Martin (Inmarsat 3)
Power plant: solar array, 2,800 watts
Dimensions: width 6.9 ft, length 5.9 ft, 57.8 ft (deployed)
Weight: 4,545 lb (Inmarsat 3)

Intelsat

Common name: Intelsat
In brief: routine communications and distribution of Armed Forces Radio and TV Services network
Function: communications
Operator: International Telecommunications Satellite Organization
First launch: April 6, 1965 (Early Bird)
Constellation: 19
Orbit altitude: 22,300 miles
Contractor: Lockheed Martin (Intelsat 8)
Power plant: solar array, 4,800 watts
Dimensions: width 8.3 x 7.2 ft, length 11.3 ft, 35.4 ft (deployed) (Intelsat 8)
Weight: 7,480 lb (Intelsat 8)

Iridium

Common name: Iridium
In brief: voice, fax, data transmission
Function: mobile communications
Operator: Iridium LLC
First launch: May 5, 1997
Constellation: 66
Orbit altitude: 484 miles
Contractor: Motorola
Power plant: solar array, 590 watts
Dimensions: diameter 3.3 ft, length 13.5 ft
Weight: 1,516 lb

Landsat

Common name: Landsat
In brief: imagery use includes mapping and planning for tactical operations
Function: remote sensing
Operator: NASA/NOAA
First launch: July 23, 1972
Constellation: one
Orbit altitude: 437 miles (polar)
Contractor: Lockheed Martin
Power plant: solar array, 1,550 watts
Dimensions: diameter 9 ft, length 14 ft
Weight: 4,800 lb

Loral Orion

Common name: Orion
In brief: commercial satellite-based, rooftop-to-rooftop communications for US Army and other DoD agencies
Function: communications
Operator: Loral Orion
First launch: November 1994
Constellation: three
Orbit altitude: 22,300 miles
Contractor: Space Systems/Loral (Orion 2)
Power plant: solar array, 7,000 watts
Dimensions: width 5.6 ft, length 6.9 ft, 72.2 ft (deployed)
Weight: 8,360 lb (Orion 2)

NOAA-14 (NOAA-J) and NOAA-15 (NOAA-K)

Common name: NOAA (with number on orbit) (also known as Television Infrared Observation Satellite or TIROS)
In brief: weather updates for all areas of the world every six hours
Function: long-term weather forecasting
Operator: NOAA (on-orbit); NASA (launch)
First launch: October 1978 (TIROS-N)
Constellation: two
Orbit altitude: 530 miles
Contractor: Lockheed Martin
Power plant: solar array, 1,000+ watts
Dimensions: diameter 6.2 ft, length 13.8 ft (NOAA-15)
Weight: 3,245 lb (NOAA-15)

Orbcomm

Common name: Orbcomm
In brief: potential military use under study in Joint Interoperability Warfighter Program
Function: mobile communications
Operator: Orbcomm Global LP
First launch: April 1995
Constellation: 28
Orbit altitude: 500–1,200 miles
Contractor: Orbital Sciences
Power plant: solar array, 220 watts
Dimensions: width 7.3 ft, length 14.2 ft
Weight: 90 lb

Satellite Pour l'Observation de la Terre

Common name: SPOT
In brief: terrain images used for mission-planning systems, terrain analysis, and mapping
Function: remote sensing
Operator: SPOT Image S.A. (France)
First launch: Feb. 22, 1986
Constellation: three
Orbit altitude: 509 miles
Contractor: Matra Marconi Space France
Power plant: solar array, 2,100 watts (SPOT 4)
Dimensions: 6.6 x 6.6 x 18.4 ft (SPOT 4)
Weight: 5,940 lb (SPOT 4)

Tracking and Data Relay Satellite System

Common name: TDRS
In brief: global network that allows other spacecraft in LEO to communicate with a control center without an elaborate network of ground stations
Function: communications relay
Operator: NASA
First launch: April 1983
Constellation: three
Orbit altitude: 22,300 miles
Contractor: TRW
Power plant: solar array, 1,800 watts
Dimensions: width 45.9 ft, length 57.4 ft (deployed)
Weight: 5,000 lb

Major US Launchers in Military Use

Athena I

Function: low- to medium-weight spacelift
Operator: commercial (AFSPC oversight)
First launch: Aug. 22, 1997
Launch site: CCAS, VAFB
Contractor: Lockheed Martin
Stages: two
Propulsion: stage 1 (Thiokol Castor 120 Solid Rocket Motor), 435,000 lb thrust; stage 2 (Pratt & Whitney Orbus 21D SRM), 43,723 lb thrust
Dimensions: length 62 ft, max body diameter 7.75 ft
Weight: 146,264 lb
Payload max: 1,750 lb to LEO

Athena II

Function: low- to medium-weight spacelift
Operator: commercial (AFSPC oversight)
First launch: Jan. 6, 1998
Launch site: CCAS, VAFB
Contractor: Lockheed Martin
Stages: three
Propulsion: stages 1–2 (Castor 120 SRMs), 435,000 lb thrust; stage 3 (Orbus 21D SRM), 43,723 lb thrust
Dimensions: length 93 ft, max body diameter 7.75 ft
Weight: 266,000 lb
Payload max: 4,350 lb to LEO

Atlas II

Function: medium-weight spacelift
Variants: IIA and IIAS
Operator: commercial (AFSPC oversight)
First launch: Dec. 7, 1991; Feb. 10, 1992 (USAF)
Launch site: CCAS, VAFB
Contractor: Lockheed Martin
Stages: two
Propulsion: (IIA and IIAS) stages 1–2 (Boeing MA-5A), 490,000 lb thrust; (IIAS) four strap-on Castor IVA SRMs
Dimensions: length 82 ft, max body diameter 10 ft
Weight: with large payload fairing (IIA) 408,800 lb; (IIAS) 515,333 lb
Payload max: (IIA) 14,500 lb to LEO; (IIAS) 19,050 lb to LEO

Delta II

Function: medium-weight spacelift
Operator: commercial (AFSPC oversight)
First launch: Feb. 14, 1989
Launch site: CCAS, VAFB
Contractor: Boeing
Stages: up to three
Propulsion: stage 1 (Boeing RS-27A), 237,000 lb thrust; stage 2 (Aerojet AJ10-118K), 9,753 lb thrust; stage 3 (Thiokol STAR 48B SRM), 14,920 lb thrust; nine strap-on SRMs (Alliant Techsystems), 100,270 lb thrust
Dimensions: length 125.2 ft, diameter 8 ft
Weight: 511,190 lb
Payload max: 11,330 lb to LEO

Delta III

Function: medium-weight spacelift
Operator: commercial (AFSPC oversight)
First launch: Aug. 26, 1998
Launch site: CCAS
Contractor: Boeing
Stages: up to two
Propulsion: stage 1 (RS-27A), 237,000 lb thrust; stage 2 (Pratt & Whitney RL10B-2), 9,750 lb thrust; nine strap-on SRMs (Alliant Techsystems), 100,270 lb thrust
Dimensions: length 148 ft, diameter 13 ft
Weight: 663,200 lb
Payload max: 18,200 lb to LEO

Evolved Expendable Launch Vehicle

Function: medium/heavy spacelift
Variants: Delta IV Medium/Heavy; Atlas V Intermediate/Heavy
Operator: commercial (AFSPC oversight)
First launch: (Medium) planned first goverment, FY2002; (Heavy) planned first government, FY2003
Launch site: CCAS, VAFB
Contractors: Boeing (19 launches) and Lockheed Martin (nine launches)
Stages: Delta IV: two; Atlas V: two
Propulsion: Delta IV: Rocketdyne RS-68 (Heavy, two additional core engines), 650,000 lb thrust; stage 2 (Medium), P&W RL10B-2, 9,750 lb thrust. Atlas V: RD AMROSS LLC RD-180 (Heavy, two additional core engines), 860,200 lb thrust; stage 2 (both) Centaur, one or two P&W RL10A-4s, 44,600 lb thrust total
Dimensions: Delta IV: length 235 ft, diameter (Medium) 13 ft, (Heavy) 16.7 ft. Atlas V: length 89 ft, diameter 12.5 ft
Weight: Atlas V, 734,850 lb–1.2 million lb
Payload max: (medium) 2,500 lb to LEO; (heavy) 45,000 lb to LEO

Pegasus

Function: low-weight spacelift
Variants: Standard and XL
Operator: commercial (AFSPC oversight)
First launch: (Standard) April 5, 1990; (XL) June 27, 1994
Launch site: dropped from L-1011 aircraft
Contractor: Orbital Sciences
Stages: three
Propulsion: (XL) stage 1, 109,400 lb thrust; stage 2, 27,600 lb thrust; stage 3, 7,800 lb thrust (all Alliant Techsystems)
Dimensions: length 49 ft, wingspan 22 ft, diameter 4.17 ft
Weight: 42,000 lb
Payload max: (Standard) 850 lb to LEO; (XL) 1,050 lb to LEO

Space Shuttle
Function: heavy-weight manned spacelift
Operator: United Space Alliance (NASA contract)
First launch: April 12, 1981
Launch site: Kennedy Space Center, Fla.
Contractor: Boeing
Stages: delta-winged orbiter
Propulsion: three main engines, 394,000 lb thrust; two SRMs, 3.3 million lb thrust
Dimensions: system length 184.2 ft; span 76.6 ft
Weight: 4.5 million lb (gross)
Payload max: 55,000 lb to LEO

Taurus
Function: low-weight spacelift
Operator: commercial (AFSPC oversight)
First launch: March 13, 1994
Launch site: CCAS, VAFB, Wallops Is.
Contractor: Orbital Sciences
Stages: three
Propulsion: Castor 120 SRM, 495,400 lb thrust; stage 1, 109,140 lb thrust; stage 2, 26,900 lb thrust; stage 3, 7,200 lb thrust (stages 1–3, Alliant Techsystems)
Dimensions: length 89 ft, max body diameter 7.6 ft
Weight: 50,000 lb
Payload max: 3,000 lb to LEO

Titan II
Function: low- to medium-weight spacelift
Operator: commercial (AFSPC oversight)
First launch: April 8, 1964 (NASA); Sept. 5, 1988 (USAF)
Launch site: VAFB
Contractor: Lockheed Martin
Stages: two
Propulsion: stage 1, 430,000 lb thrust; stage 2, 100,000 lb thrust (both Aerojet)
Dimensions: length 94 ft, diameter 10 ft
Weight: 408,000 lb
Payload max: 4,200 lb to polar LEO

Titan IVB
Function: heavy-weight spacelift
Operator: commercial (AFSPC oversight)
First launch: (IVB) Feb. 23, 1997
Launch site: CCAS, VAFB
Contractor: Lockheed Martin
Stages: two; may add Centaur or Inertial Upper Stages
Propulsion: two SRM Upgrades (Alliant Techsystems), 1.7 million lb thrust each; stage 1 (LR87-AJ-11), 552,500 lb thrust; stage 2 (LR91-AJ-11), 105,000 lb thrust (stages 1–2, Aerojet); Centaur, 33,000 lb thrust; IUS (Boeing), 41,700 lb thrust
Dimensions: length (stage 1–2) 119.2 ft, diameter 10 ft
Weight: 1.9 million lb
Payload max: 47,800 lb to LEO

Selected NASA Projects Fiscal 2000 Proposal (Current Dollars)

■ **Cassini, no new FY2000 funding, activity ongoing.** Space science. Spacecraft mission to Saturn. Seeks data on formation of solar system and on how the building blocks needed for the chemical evolution of life are formed elsewhere in the universe. Launched in October 1997. Scheduled to arrive in Saturnian system in 2004.

■ **Chandra X-ray Observatory, $60.7 million.** Space science. The Advanced X-ray Astrophysics Facility (AXAF) spacecraft was renamed the Chandra X-ray Observatory in December 1998 after the late American Nobel Laureate Subrahmanyan Chandrasekhar, who made key contributions to the study of black holes and other phenomena. The observatory's mission is to study such interstellar phenomena, as well as the composition and nature of galaxies and stellar objects. Scheduled for launch aboard the space shuttle in July 1999.

■ **Discovery, $180.5 million.** Space science. Lunar Prospector launched in January 1998. In March 1998, its instruments detected significant amounts of water–ice in the shaded polar regions. The Stardust mission, launched in February 1999, is designed to gather dust samples from the comet Wild-2 and return the samples to Earth for analysis. Discovery is intended as NASA's low-cost planetary exploration program. NASA's next two Discovery missions are Genesis, which will collect samples of charged particles in the solar wind and return to Earth laboratories for study; and the Comet Nucleus Tour (Contour), which will intercept and collect data on three comets. Launch for Genesis is January 2001, and launch for Contour is June 2002.

■ **Earth Observing System, $663.2 million.** Earth Science Enterprise (formerly Mission to Planet Earth) environmental project. Series of satellites to document global climatic change and observe environmental processes. Scheduled launches start in 1999.

■ **Explorer, $151.0 million.** Space science. Four missions and spacecraft development. Study of X-ray sources, solar corona, and organic compounds in interstellar clouds. Scheduled launches each year from 1998 to 2001.

■ **Galileo, no new FY2000 funding, activity ongoing.** Space science, planetary exploration. Funds to support operations of mission to explore Jupiter and its moons.

■ **Mars Surveyor, $250.7 million.** Space science. Launch of the Mars Global Surveyor orbiter occurred in November 1996. It arrived in September 1997. Development of spacecraft for new Mars exploration strategy. Mapping, in situ climate and soil measurements, and eventual goal to return rock samples from Mars. Follow-on orbiter launched December 1998, and the first lander launched January 1999.

■ **New Millennium Spacecraft, $16.1 million.** Space science. Flight-technology demonstration to produce new microspacecraft with reduced weight and life-cycle costs. Funding increase to spur deep-space mission technology and development. Deep Space 1 mission, launched in October 1998, tested several new technologies during its flight. Deep Space 2 spacecraft was launched in January 1999, attached to the Mars Polar Lander. DS 2 will develop and validate technologies and systems to deliver small packages to the surface and subsurface of Mars.

■ **Relativity (Gravity Probe B), $40.5 million.** Space science. Major test of Einstein's general theory of relativity. Development of a gravity probe. Launch is scheduled for October 2000.

■ **Space shuttle, $3.0 billion.** Spaceflight. Program emphasizes continuing improvement of safety margins, fulfillment of the flight manifest, reduction of costs, and launch of eight flights for Fiscal 2000 and nine in Fiscal 2001.

■ **International Space Station, $2.5 billion.** Spaceflight. International manned space facility. Ultimate capacity for seven persons. The first three inhabitants will arrive in early 2000, aboard a Soyuz rocket. ISS Commander Bill Shepherd will be the first US astronaut to live in the station, along with Russian cosmonauts Sergei Krikalev and Yuri Gidzenko. Station scientists will eventually be able to conduct experiments in six research facilities, including biotechnology and gravitational biology facilities.

■ **Russian Program Assurance, $200,000.** Spaceflight. Program provides for contract with Russian Space Agency for services and hardware and joint activities with Russia on the Mir and ISS. The ninth and final joint shuttle–Mir mission took place in June 1998.

■ **Other space operations, $375.1 million.** Space science. Operation of Hubble Space Telescope, the Chandra X-ray Observatory program, the Compton Gamma Ray Observatory, and the International Solar Terrestrial Physics program. Support of planetary missions includes Galileo, NEAR, Mars Surveyor, Cassini, Lunar Prospector, and Stardust.

Russian Operational Spacecraft

(As of Dec. 31, 1998)

Mission	Type	Number
Communications	Kosmos (Strela-3)	15
	Gonets-D	6
	Raduga/Raduga-1	5
	Gorizont	10
	Molniya-1	4
	Molniya-3	4
	Kosmos (Geizer)	2
	Luch-1	1
	Ekran-M	1
	Ekspress	2
	Gals	2
Navigation	Kosmos GLONASS	20
	Kosmos (military)	6
	Kosmos (civil)	4
Meteorology	Meteor-3	1
Early warning	Kosmos (Oko)	6
	Kosmos (Prognoz)	2
Electronic intelligence	Kosmos (Tselina-2)	2
	Kosmos (EORSAT)	1
Photoreconnaissance	Yantar-1 KFT	1
	Kosmos (Yantar-4K class)	2
	Kosmos (Arkon-1)	1
Remote sensing	Okean-O	2
	Resurs-01	2
	Sich	1
Geodesy	Kosmos (Etalon)	2
	Kosmos (GEO-IK)	1
Space station activity	Mir	1
	Kvant-1	1
	Kvant-2	1
	Kristall	1
	Spektr	1
	Priroda	1
	Soyuz TM	1
	Progress M	1
	Zarya (ISS)	1

Russian Payloads by Mission, 1957–98

(As of Dec. 31, 1998)

Platforms	**498**
Earth orbital science	**211**
Automated lunar, planetary	**86**
Moon	34
Mercury	0
Venus	33
Mars	19
Outer planets	0
Interplanetary space	0
Applications	**520**
Communications	304
Weather	74
Geodesy	34
Earth resources	98
Materials processing	10
Piloted activities	**249**
Earth orbital	87
Earth orbital (related)	154
Lunar	0
Lunar (related)	8
Launch vehicle tests	**22**
General engineering tests	**4**
Reconnaissance	**1,094**
Photographic	801
Electronic intelligence	132
Ocean electronic intelligence	83
Early warning	78
Minor military operations	**161**
Navigation	**218**
Theater communication	**535**
Weapons-related activities	**56**
Fractional orbital bombardment	18
Anti-satellite targets	18
Anti-satellite interceptors	20
Other military	**1**
Other civilian	**2**
Total	**3,657**

A shuttle pilot does not deploy the orbiter's landing gear until the spacecraft reaches an altitude of only 250 feet above ground level and a speed of less than 345 mph.

Activities

Russian Military vs. Civilian Launches

(As of Dec. 31, 1998)

Year	Military	Civilian	Total
1957	0	2	2
1958	0	1	1
1959	0	3	3
1960	0	3	3
1961	0	6	6
1962	5	15	20
1963	7	10	17
1964	15	15	30
1965	25	23	48
1966	27	17	44
1967	46	20	66
1968	49	25	74
1969	51	19	70
1970	55	26	81
1971	60	23	83
1972	53	21	74
1973	58	28	86
1974	52	29	81
1975	60	29	89
1976	74	25	99
1977	69	29	98
1978	60	28	88
1979	60	27	87
1980	64	25	89
1981	59	39	98
1982	68	33	101
1983	58	40	98
1984	63	34	97
1985	64	34	98
1986	63	28	91
1987	62	33	95
1988	53	37	90
1989	42	32	74
1990	45	30	75
1991	30	29	59
1992	32	22	54
1993	26	21	47
1994	26	22	48
1995	15	17	32
1996	8	17	25
1997	10	18	28
1998	9	15	24
Total	**1,623**	**950**	**2,573**

Russian Launches

(As of Dec. 31, 1998)

	Launches	Spacecraft
Communications	3	8
Photoreconnaissance	3	3
Unmanned space station resupply	3	3
Navigation	3	5
Manned flight	2	2
Commercial/Foreign	6	18
Remote sensing	1	1
Early warning	2	2
Space station module	1	1
Amateur radio	*	1
Total	**24**	**44**

Russian Launch Site Activity

(As of Dec. 31, 1998)

Spacecraft	Number of launches
Baikonur Cosmodrome, Tyuratam, Kazakhstan	
Proton-K	7
Soyuz-U	7
Zenit-2	2
Total	**16**
Plesetsk Cosmodrome, Plesetsk, Russia	
Tsyklon-3	1
Kosmos-3M	2
Soyuz-U	1
Molniya-M	3
Total	**7**
Barents Sea (submarine launch)	
Shtil-1*	1
Total	**1**

*Launched from submerged submarine in Barents Sea, world's first satellite launch from a submarine.

Russian Manned Spaceflights

(As of Dec. 31, 1998)

Year	Flights	Persons*
1961	2	2
1962	2	2
1963	2	2
1964	1	3
1965	1	2
1966	0	0
1967	1	1
1968	1	1
1969	5	11
1970	1	2
1971	2	6
1972	0	0
1973	2	4
1974	3	6
1975	4	8
1976	3	6
1977	3	6
1978	5	10
1979	2	4
1980	6	13
1981	3	6
1982	3	8
1983	2	5
1984	3	9
1985	2	5
1986	1	2
1987	3	8
1988	3	9
1989	1	2
1990	3	7
1991	2	6
1992	2	6
1993	2	5
1994	3	8
1995	2	6
1996	2	5
1997	2	5
1998	2	6
Total	**87**	**197**

*Total number of personnel who flew in space in a given year. (Individuals may have made multiple flights.)

Spacefarers*

(As of Dec. 31, 1998)

Nation	Persons	Nation	Persons
Afghanistan	1	Mongolia	1
Austria	1	Netherlands	1
Belgium	1	Poland	1
Bulgaria	2	Romania	1
Canada	7	Russia	89
Cuba	1	Saudi Arabia	1
Czechoslovakia	1	Spain	1
France	8	Switzerland	1
Germany	8	Syria	1
Hungary	1	Ukraine	1
India	1	United Kingdom	1
Italy	3	United States	243
Japan	5	Vietnam	1
Mexico	1	**Total**	**384**

*Individuals who have flown in space.

Payloads in Orbit

(As of Dec. 31, 1998)

Launcher/operator	Objects	Launcher/operator	Objects
Argentina	6	Luxembourg	8
Australia	7	Malaysia	2
Brazil	8	Mexico	6
Canada	15	NATO	8
Chile	1	Norway	3
China	26	Philippines	2
Czechoslovakia	4	Portugal	1
Egypt	1	Russia	1,374
ESA	36	Saudi Arabia	6
France	34	Singapore	1
France/Germany	2	South Korea	4
Germany	18	Spain	5
India	17	Sweden	8
Indonesia	8	Thailand	4
Israel	3	Turkey	2
Italy	7	United Kingdom	26
ITSO*	56	United States	869
Japan	67	**Total**	**2,645**

*International Telecommunications Satellite Organization

Other, Launches

(As of Dec. 31, 1998)

Year	France	China	Japan	Europe	India	Israel
1965	1					
1966	1					
1967	2					
1968						
1969						
1970	2	1	1			
1971	1	1	2			
1972			1			
1973						
1974			1			
1975	3	3	2			
1976		2	1			
1977			2			
1978		1	3			
1979			2	1		
1980			2		1	
1981		1	3	2	1	
1982		1	1			
1983		1	3	2	1	
1984		3	3	4		
1985		1	2	3		
1986		2	2	2		
1987		2	3	2		
1988		4	2	7		1
1989			2	7		
1990		5	3	5		1
1991		1	2	8		
1992		4	1	7	1	
1993		1	1	7		
1994		5	2	6	2	
1995		2	1	11		1
1996		3	1	10	1	
1997		6	2	12	1	
1998		6	2	11		
Total	**10**	**56**	**53**	**107**	**8**	**3**

Space Lore

Space Firsts

Feb. 24, 1949
Project Bumper, the first fully successful two-stage rocket-launch into space, reaches a record altitude of 244 miles.
July 24, 1950
Bumper–WAC becomes first missile launched from Cape Canaveral, Fla.
Sept. 20, 1956
US Jupiter C rocket achieves record first flight, reaching an altitude of 682 miles and landing 3,400 miles from Cape Canaveral.
Aug. 21, 1957
First successful launch of Soviet R7 rocket, which six weeks later will loft Sputnik into orbit.
Oct. 4
USSR launches Sputnik 1, the first man-made satellite, into Earth orbit.
Nov. 3
First animal in orbit, a dog, is carried aloft by Soviet Sputnik 2.
Dec. 6
First US attempt to orbit satellite fails when Vanguard rocket loses thrust and explodes.
Dec. 17
First successful Atlas booster launch.
Jan. 31, 1958
Explorer 1, first US satellite, launched.
May 15
USSR launches first automatic scientific lab aboard Sputnik 3, proving satellites can have important military uses.
Dec. 18
Project Score spacecraft conducts first US active communication from space.
Feb. 28, 1959
Discoverer 1 becomes first satellite launched from Vandenberg AFB, Calif.
June 9
First engineer group arrives at Cape Canaveral to prepare Atlas booster carrying first Mercury capsule.
Aug. 7
Explorer 6 spacecraft transmits first television pictures from space.
Sept. 12
Soviet Union launches Luna 2, which two days later becomes first man-made object to strike the moon.
April 1, 1960
TIROS 1 becomes first US weather satellite to go aloft.
April 13
Transit 1B becomes first US navigation satellite in space.
May 24
Atlas D/Agena A booster places MIDAS II, first early warning satellite, in orbit.
June 22
US performs first successful launch of multiple independently instrumented satellites by a single rocket.
Aug. 11
Capsule ejected from Discoverer 13 parachutes into Pacific Ocean and becomes first orbital payload ever recovered.
Aug. 12
First passive communications carried via Echo 1 satellite.
Aug. 19
Capsule containing first satellite photographs of Soviet Union ejected from Discoverer 14 becomes first orbital payload recovered in midair by C-119 Flying Boxcar.
Jan. 31, 1961
Preparing for manned spaceflight, US launches a Mercury capsule carrying the chimpanzee Ham on a suborbital trajectory.
Feb. 16
Explorer 9 becomes first satellite launched from Wallops Island, Va.
April 12
Soviet cosmonaut Yuri Gagarin pilots Vostok 1 through nearly one orbit to become first human in space.
May 5
Lt. Cmdr. Alan B. Shepard Jr., aboard Freedom 7 Mercury capsule, becomes first American in space, climbing to 116.5 miles during suborbital flight lasting 15 minutes, 28 seconds.
Oct. 27
First flight of Saturn rocket marks beginning of more than 11 years of Apollo launches.
Feb. 20, 1962
Project Mercury astronaut Lt. Col. John H. Glenn Jr., aboard the Friendship 7 capsule, completes the first US manned orbital flight.
July 17
Air Force Capt. Robert M. White earns astronaut wings when he reaches altitude of nearly 60 miles in rocket-powered X-15, the first aircraft to be flown to the lower edge of space, considered to be 50 miles.
Dec. 14
Mariner 2 passes Venus at a distance of 21,600 miles, becoming the first space probe to encounter another planet.
June 16, 1963
Valentina Tereshkova of USSR pilots Vostok 6 to become first woman in space.
July 26
Hughes Corp.'s Syncom 2 (prototype of EarlyBird communications satellite) orbits and "parks" over the Atlantic to become world's first geosynchronous satellite.
Oct. 17
Vela Hotel satellite performs first space-based detection of a nuclear explosion.
July 28, 1964
First close-up lunar pictures provided by Ranger 7 spacecraft.
Aug. 14
First Atlas/Agena D standard launch vehicle successfully fired from Vandenberg AFB.
March 18, 1965
First space walk conducted by Alexei Leonov of Soviet Voskhod 2.
March 23
Gemini 3 astronauts Maj. Virgil I. "Gus" Grissom and Lt. Cmdr. John W. Young complete world's first piloted orbital maneuver.
June 4
Gemini 4 astronaut Maj. Edward H. White performs first American space walk.
July 14
Mariner provides the first close-up pictures of Mars.
Aug. 21
Gemini 5 launched as first manned spacecraft using fuel cells for electrical power rather than batteries.
March 16, 1966
Gemini 8 astronauts Neil A. Armstrong and Maj. David R. Scott perform first manual docking in space with Agena rocket stage.
June 2
Surveyor 1 is first US spacecraft to land softly on the moon. It analyzes soil content and transmits surface images to Earth.
Jan. 25, 1967
Soviet Kosmos 139 anti-satellite weapon carries out first fractional orbit bombardment.
Jan. 27
First deaths of US space program occur in flash fire in Apollo 1 command module, killing astronauts Grissom, White, and Lt. Cmdr. Roger B. Chaffee.
Sept. 8
Surveyor 5 conducts first chemical analysis of lunar soil.
Oct. 20, 1968
Soviet Kosmos 248 and Kosmos 249 spacecraft carry out first co-orbital anti-satellite test.
Dec. 21–27
Apollo 8 becomes first manned spacecraft to escape Earth's gravity and enter lunar orbit. First live lunar television broadcast.
March 3–13, 1969
Apollo 9 crew members Col. James A. McDivitt, Col. David R. Scott, and Russell L. Schweickart conduct first test of lunar module in Earth orbit.
July 20
Apollo 11 puts first human, Neil A. Armstrong, on the moon.
Nov. 14–24
US Apollo 12 mission deploys first major scientific experiments on the moon and completes first acquisition of samples from an earlier spacecraft—Surveyor 3.
Feb. 11, 1970
Japan launches first satellite, Osumi, from Kagoshima Space Center using Lambda 4S solid-fuel rocket.
Jan. 31, 1971
Apollo 14 launched; its astronauts will complete first manned landing on lunar highlands.
April 19
First space station, Salyut 1, goes aloft.

June 6
USSR's Soyuz 11 performs first successful docking with Salyut space station.
Oct. 28
First British satellite, Prospero, launched into orbit on Black Arrow rocket.
Nov. 2
Titan IIIC launches first Defense Satellite Communications System (DSCS) Phase II satellites into GEO.
April 16–27, 1972
Apollo 16 astronauts Capt. John Young, Lt. Cmdr. Thomas K. Mattingly II, and Lt. Col. Charles M. Duke Jr. are first to use the moon as an astronomical laboratory.
July 23
US launches first Earth Resources Technology Satellite (ERTS A), later renamed Landsat 1.
Dec. 3, 1973
Pioneer 10 becomes first space probe to come within reach of Jupiter.
July 15, 1975
US Apollo and Soviet Soyuz 19 perform first international docking of spacecraft in space.
July 20, 1976
NASA's Viking 1 performs first soft landing on Mars and begins capturing images of Red Planet's surface.
Aug. 12, 1977
Space shuttle *Enterprise* performs first free flight after release from a Boeing 747 at 22,800 feet.
Feb. 22, 1978
Atlas booster carries first Global Positioning System (GPS) Block I satellite into orbit.
Dec. 13
Successful launch of two DSCS II satellites puts a full four-satellite constellation at users' disposal for first time.
July 18, 1980
India places its first satellite, Rohini 1, into orbit using its own SLV-3 launcher.
April 12–14, 1981
First orbital flight of shuttle *Columbia* (STS-1) and first landing from orbit of reusable spacecraft.
Dec. 20, 1982
First Defense Meteorological Satellite Program (DMSP) Block 5D-2 satellite launched.
June 13, 1983
Pioneer 10 becomes first spacecraft to leave solar system.
June 18
Space shuttle *Challenger* crew member Sally K. Ride becomes first American woman in space.
Sept. 11, 1985
International Cometary Explorer becomes first man-made object to encounter a comet (Giacobini–Zinner).
Sept. 13
First US anti-satellite intercept test destroys Solwind scientific satellite by air-launched weapon.
Oct. 3, 1985
First launch of *Atlantis* (STS-51J) results in first launch of pair of DSCS III satellites from space shuttle using Inertial Upper Stage.
Jan. 28, 1986
Space shuttle *Challenger* explodes after liftoff, killing seven astronauts.
Feb. 22
France launches first *Satellite Pour l'Observation de la Terre* (SPOT) for remote sensing.
Aug. 12
First launch of Japanese H-I rocket puts Experimental Geodetic Satellite into circular orbit.
May 15, 1987
USSR stages first flight of its Energia heavy launcher, designed to lift 100 tons into LEO.
Nov. 15, 1988
USSR makes first launch of 30-ton shuttle *Buran* using Energia rocket.
Feb. 14, 1989
Launch of first Block II GPS satellite begins an operational constellation.
Jan. 17, 1991
What the Air Force calls "the first space war," Operation Desert Storm, opens with air attacks.
Oct. 29
Galileo swings within 10,000 miles of Gaspra, snapping first close-up images of an asteroid.
May 13, 1992
The first trio of space-walking astronauts, working from the shuttle *Endeavour,* rescues Intelsat 6 from useless low orbit.
Jan. 13, 1993
USAF Maj. Susan Helms, flying aboard *Endeavour,* becomes first US military woman in space.
July 19
Launch of a DSCS Phase III satellite into GEO provides the first full five-satellite DSCS III constellation.
Dec. 2–13
USAF Col. Richard O. Covey pilots shuttle *Endeavour* on successful $674 million mission to repair $2 billion Hubble Space Telescope, a mission for which the crew wins the 1993 Collier Trophy.
Jan. 25, 1994
Launch of the 500-pound unpiloted Clementine spacecraft marks the first post–Apollo US lunar mission.
Feb. 7 First Titan IV Centaur booster launches first Milstar Block I satellite into orbit.
March 13
First launch of Taurus booster (from Vandenberg AFB) places two military satellites in orbit.
June 29
First visit of a US space shuttle to a space station, the Russian Mir.
Nov. 5
Ulysses, first probe to explore the sun's environment at high latitudes, completes a pass over the sun's southern pole and reveals that solar wind's velocity at high latitudes (i.e., about two million mph) is nearly twice its velocity at lower latitudes.
Feb. 6, 1995
Shuttle *Discovery* (STS-63) and space station Mir perform first US–Russian space rendezvous in 20 years, with Air Force Lt. Col. Eileen M. Collins coincidentally becoming first woman to pilot a US spaceship.
March 14
US astronaut Norman E. Thagard becomes first American to accompany Russian cosmonauts aboard Soyuz TM-21 spacecraft and, two days later, becomes first American to inhabit space station Mir.
June 29
Atlantis (STS-71) docks with Mir, the first docking of a US spacecraft and a Russian space station.
March 8, 1996
First successful launch of Pegasus XL rocket from beneath modified L-1011 aircraft sends Air Force Radiation Experiment–II satellite into polar orbit.
June 27
Galileo captures first close-up images of Jupiter's moon Ganymede.
April 21, 1997
Celestis, Inc., of Houston performs first space "burial" when Pegasus rocket launched from L-1011 off coast of northwest Africa carries cremated remains of "Star Trek" creator Gene Roddenberry, LSD guru Timothy Leary, and 22 other space enthusiasts into orbit 300 miles above Earth.
April 29
US astronaut Jerry Linenger and Russian cosmonaut Vasily Tsibliev complete five-hour space walk outside Mir, the first such joint excursion in space history.
June 27
In first flyby of "dark, primitive main-belt" type asteroid, NASA's Near-Earth Asteroid Rendezvous spacecraft passes 253 Mathilde.
July 5
One day after Mars Pathfinder lands on surface of Red Planet, Sojourner rover becomes first mobile, semiautonomous, robotic vehicle to traverse another planet's surface.
May 29, 1998
First transfer of operational military space system to civilian agency occurs when Air Force hands to NOAA control of DMSP spacecraft.
June 17
Hughes completes first commercial mission to moon, having used dual lunar flybys to maneuver errant HGS-1 satellite into usable, geosynchronous orbit.

Space Terms

Aerospace. A physical region made up of Earth's atmosphere and the space beyond.

Aerospace plane. A reusable spacecraft able to operate effectively in both the atmosphere and space. Also known as a "transatmospheric vehicle" or, more currently, "spaceplane."

Apogee. The point of greatest distance from Earth (or the moon, a planet, etc.) achieved by a body in elliptical orbit. Usually expressed as distance from Earth's surface.

Atmosphere. Earth's enveloping sphere of air.

Boost phase. Powered flight of a ballistic missile—i.e., before the rocket burns out.

Burn. The process in which rocket engines consume fuel or other propellant.

Circumterrestrial space. "Inner space" or the atmospheric region that extends from 60 miles to about 50,000 miles from Earth's surface.

Constellation. A formation of satellites orbiting for a specific combined purpose.

Deep space. All space beyond the Earth–moon system, or from about 480,000 miles altitude outward.

Eccentric orbit. An extremely elongated elliptical orbit.

Ecliptic plane. The plane defined by the circle on the celestial sphere traced by the path of the sun.

Elliptical orbit. Any noncircular, closed spaceflight path.

Exosphere. The upper limits of Earth's atmosphere, ranging from about 300 miles altitude to about 2,000 miles altitude.

Expendable Launch Vehicle (ELV). A launch vehicle that cannot be reused after one flight.

Ferret. A satellite whose primary function is to gather electronic intelligence, such as microwave, radar, radio, and voice emissions.

Geostationary Earth orbit. A geosynchronous orbit with 0° inclination in which the spacecraft circles Earth 22,300 miles above the equator and appears from Earth to be standing still.

Geosynchronous Earth Orbit (GEO). An orbit at 22,300 miles that is synchronized with Earth's rotation. If a satellite in GEO is not at 0° inclination, its ground path describes a figure eight as it travels around Earth.

Geosynchronous Transfer Orbit (GTO). An orbit that originates with the parking orbit and then reaches apogee at the GEO.

Ground track. An imaginary line on Earth's surface that traces the course of another imaginary line between Earth's center and an orbiting satellite.

High Earth Orbit (HEO). Flight path above geosynchronous altitude (22,300 to 60,000 miles from Earth's surface).

High-resolution imagery. Detailed representations of actual objects that satellites produce electronically or optically on displays, film, or other visual devices.

Inertial Upper Stage (IUS). A two-stage solid-rocket motor used to propel heavy satellites into mission orbit.

Ionosphere. A region of electrically charged thin air layers that begins about 30 miles above Earth's atmosphere.

Low Earth Orbit (LEO). Flight path between Earth's atmosphere and the bottom of the Van Allen belts, i.e., from about 60 to 300 miles altitude.

Magnetosphere. A region dominated by Earth's magnetic field, which traps charged particles, including those in the Van Allen belts. It begins in the upper atmosphere, where it overlaps the ionosphere, and extends several thousand miles farther into space.

Medium Earth Orbit (MEO). Flight path between LEO, which ends at about 300 miles altitude, and GEO, which is at an average altitude of 22,300 miles.

Mesosphere. A region of the atmosphere about 30 to 50 miles above Earth's surface.

Orbital decay. A condition in which spacecraft lose orbital altitude and orbital energy because of aerodynamic drag and other physical forces.

Orbital inclination. Angle of flight path in space relative to the equator of a planetary body. Equatorial paths are 0° for flights headed east, 180° for those headed west.

Outer space. Space that extends from about 50,000 miles above Earth's surface to a distance of about 480,000 miles.

Parking orbit. Flight path in which spacecraft go into LEO, circle the globe in a waiting posture, and then transfer payload to a final, higher orbit.

Payload. Any spacecraft's crew or cargo; the mission element supported by the spacecraft.

Perigee. The point of minimum altitude above Earth (or the moon, a planet, etc.) maintained by a body in elliptical orbit.

Period. The amount of time a spacecraft requires to go through one complete orbit.

Polar orbit. Earth orbit with a 90° inclination. Spacecraft on this path could pass over every spot on Earth as Earth rotates under the satellite's orbit (see orbital inclination).

Remote imaging. Images of Earth generated from a spacecraft that provide data for mapping, construction, agriculture, oil and gas exploration, news media services, and the like.

Reusable Launch Vehicle (RLV). A launch vehicle that can be reused after flight.

Rocket. An aerospace vehicle that carries its own fuel and oxidizer and can operate outside Earth's atmosphere.

Semisynchronous orbit. An orbit set at an altitude of 12,834 miles. Satellites in this orbit revolve around Earth in exactly 12 hours.

Single-Stage-To-Orbit (SSTO) system. A reusable single-stage rocket that can take off and land repeatedly and is able to boost payloads into orbit.

Stratosphere. That section of atmosphere about 10 to 30 miles above Earth's surface.

Sun synchronous orbit. An orbit inclined about 98° to the equator and at LEO altitude. At this inclination and altitude, a satellite's orbital plane always maintains the same relative orientation to the sun.

Thermosphere. The thin atmosphere about 50 to 300 miles above Earth's surface. It experiences dramatically increased levels of heat compared to the lower layers.

Transfer. Any maneuver that changes a spacecraft orbit.

Transponder. A radar or radio set that, upon receiving a designated signal, emits a radio signal of its own.

Troposphere. The region of the atmosphere from Earth's surface to about 10 miles above the equator and five miles above the poles. This is where most clouds, wind, rain, and other weather occurs.

Van Allen belts. Zones of intense radiation trapped in Earth's magnetosphere that could damage unshielded spacecraft.

The first shuttle orbiter, the *Enterprise,* was supposed to be named *Constitution,* but fans of the popular TV program "Star Trek" mounted a successful write-in campaign convincing the White House to name the vehicle after the show's famous starship.

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The Golden Age of NASA

Name	**Project Mercury**
Duration	**Nov. 3, 1958–May 16, 1963**
Cost	$392.1 million (cost figures are in then-year dollars)
Distinction	First US manned spaceflight program
Highlight	Astronauts are launched into space and returned safely to Earth
Number of flights	Six
Key events	**May 5, 1961** Lt. Cmdr. Alan B. Shepard Jr. makes first US manned flight, a 15-minute suborbital trip **Feb. 20, 1962** Lt. Col. John H. Glenn Jr. becomes first American to orbit Earth **May 15, 1963** Maj. L. Gordon Cooper Jr. begins flight of 22 orbits in 34 hours
Name	**Project Gemini**
Duration	**Jan. 15, 1962–Nov. 15, 1966**
Cost	$1.3 billion
Distinction	First program to explore docking, long-duration flight, rendezvous, space walks, and guided re-entry
Highlight	Dockings and rendezvous techniques practiced in preparation for Project Apollo
Number of flights	10
Key events	**June 3–7, 1965** Flight in which Maj. Edward H. White II makes first space walk **Aug. 21–29, 1965** Cooper and Lt. Cmdr. Charles "Pete" Conrad Jr. withstand weightlessness **March 16, 1966** Neil A. Armstrong and Maj. David R. Scott execute the first space docking **Sept. 15, 1966** Conrad and Richard F. Gordon Jr. make first successful automatic, computer-steered re-entry
Name	**Project Apollo**
Duration	**July 25, 1960–Dec. 19, 1972**
Cost	$24 billion
Distinction	Space program that put humans on the moon
Highlights	Neil Armstrong steps onto lunar surface. Twelve astronauts spend 160 hours on the moon
Number of flights	11
Key events	**May 28, 1964** First Apollo command module is launched into orbit aboard a Saturn 1 rocket **Jan. 27, 1967** Lt. Col. Virgil I. "Gus" Grissom, Lt. Cmdr. Roger B. Chaffee, and White die in a command module fire in ground test **Oct. 11–22, 1968** First manned Apollo flight proves "moonworthiness" of spacecraft **Dec. 21–27, 1968** First manned flight to moon and first lunar orbit **July 16–24, 1969** Apollo 11 takes Armstrong, Col. Edwin E. "Buzz" Aldrin Jr., and Lt. Col. Michael Collins to the moon and back Armstrong and Aldrin make first and second moon walks **Dec. 7–19, 1972** Final Apollo lunar flight produces sixth manned moon landing

Astronauts Mark E. Kelly and Scott J. Kelly, members of the 1996 group, are twins, the only siblings ever selected.

Anthony W. England, accepted for astronaut training in 1967 at age 25, is the youngest person ever accepted into the program. He flew only one mission, in 1985.