

2005 Space AI

Stratosphere begins **10 miles**

Limit for turbojet engines **20 miles**

Limit for ramjet engines **28 miles**

Astronaut wings awarded **50 miles**

Low Earth orbit begins **60 miles**

0.95G **100 miles**

Medium Earth orbit begins **300 miles**

The US military space operation in facts and figures.

manac

Compiled by **Tamar A. Mehuron**, Associate Editor, and the staff of *Air Force Magazine*

Hard vacuum 1,000 miles

Geosynchronous Earth orbit 22,300 miles

0.05G 60,000 miles

NASA photo/staff illustration by Zaur Eylanbekov

Illustration not to scale

US Military Missions in Space

Space Force Support

Launch of satellites and other high-value payloads into space and operation of those satellites through a worldwide network of ground stations.

Space Force Enhancement

Provide satellite communications, navigation, weather, missile warning, and intelligence to the warfighter.

Space Control

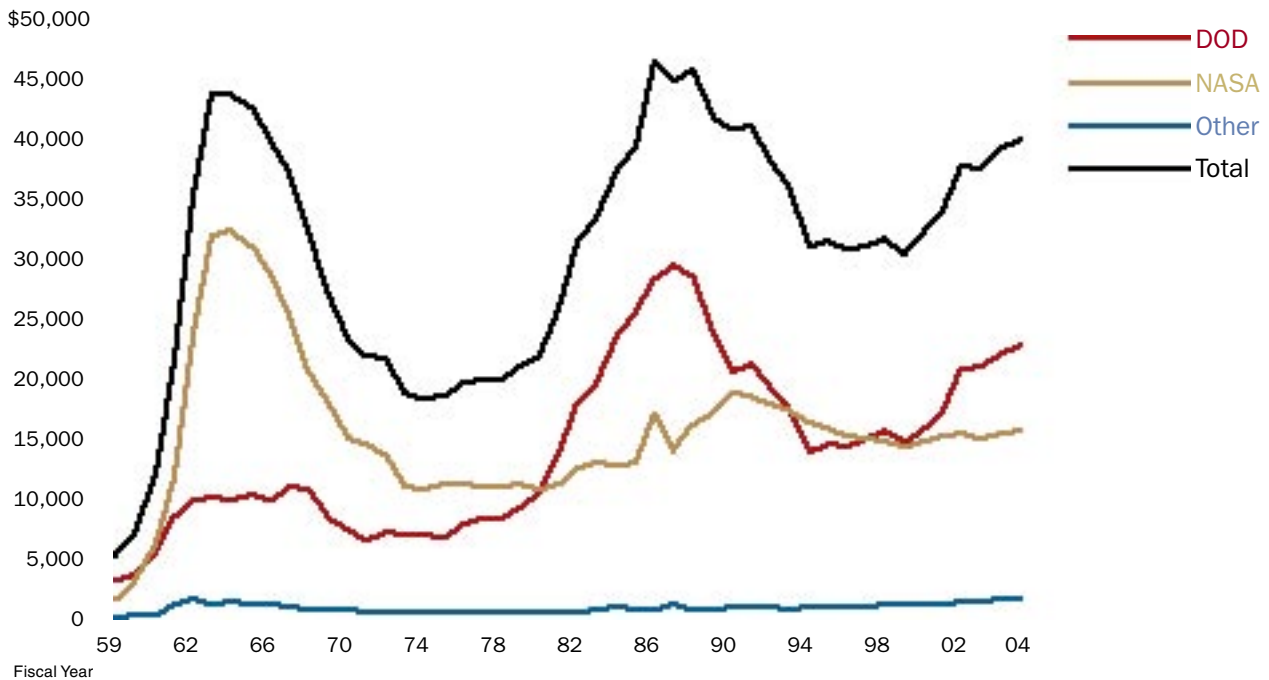
Assure US access to and freedom of operation in space and deny enemies the use of space.

Space Force Application

Pursue research and development of capabilities for the probable application of combat operations in, through, and from space to influence the course and outcome of conflict.

US Space Funding

Millions of constant FY06 dollars



FY	NASA	DOD	Other	Total	FY	NASA	DOD	Other	Total
1959	1,769	3,321	230	5,320	1983	12,536	17,867	648	31,051
1960	3,078	3,738	287	7,103	1984	13,026	19,364	750	33,140
1961	6,109	5,370	449	11,928	1985	12,696	23,409	1,070	37,175
1962	11,738	8,479	1,300	21,517	1986	12,891	25,416	858	39,165
1963	23,381	9,995	1,657	35,033	1987	17,035	28,285	809	46,129
1964	31,929	10,178	1,356	43,464	1988	13,883	29,494	1,236	44,613
1965	32,191	9,862	1,510	43,562	1989	16,073	28,504	892	45,469
1966	30,839	10,284	1,303	42,426	1990	17,308	23,585	764	41,657
1967	28,524	9,827	1,258	39,609	1991	18,909	20,554	1,119	40,583
1968	25,107	10,893	987	36,988	1992	18,574	21,141	1,123	40,837
1969	20,532	10,814	915	32,261	1993	17,848	19,272	999	38,119
1970	18,027	8,528	717	27,272	1994	17,340	17,532	842	35,714
1971	15,096	7,361	788	23,245	1995	16,247	13,788	983	31,018
1972	14,487	6,637	629	21,753	1996	15,807	14,480	1,041	31,328
1973	13,739	7,209	655	21,602	1997	15,314	14,416	971	30,701
1974	11,041	7,067	633	18,740	1998	14,908	14,954	1,016	30,878
1975	10,692	6,940	579	18,210	1999	14,751	15,631	1,163	31,545
1976	11,180	6,875	584	18,639	2000	14,337	14,817	1,209	30,363
1977	11,198	7,852	630	19,680	2001	14,818	15,957	1,183	31,958
1978	10,961	8,283	684	19,928	2002	15,206	17,255	1,311	33,773
1979	10,954	8,252	674	19,881	2003	15,389	20,777	1,398	37,564
1980	11,208	9,215	553	20,977	2004	14,915	20,889	1,529	37,333
1981	10,839	10,483	509	21,830	Total	\$715,736	\$638,505	\$42,436	\$1,396,676
1982	11,302	13,655	639	25,596					

The Year in Space

Aug. 31, 2004

Lockheed Martin launches 63rd and final Atlas II ... NRO payload boosted to orbit from Cape Canaveral AFS, Fla. ... Atlas II sustained perfect launch record since 1991.

Sept. 2

Hurricane Frances forces mass evacuation of Patrick AFB, Fla., and the East Coast Launch Facility ... First since 1989's Hurricane Hugo ... Significant destruction across facility spares Delta II, Delta III, and Titan IVB launch vehicles on pads at Cape Canaveral.

Sept. 24

USAF achieves initial operational capability with Counter Communications System ... Designed to disrupt enemy communications satellites using reversible, nondestructive means.

Sept. 29

Privately built *SpaceShipOne* achieves suborbit, reaching 62.2 miles on the first of two record-setting flights ... Captures Ansari X Prize of \$10 million and Collier Trophy ... Demonstrates low-cost access to space and boosts prospects for eventual commercial space tourism.

Oct. 1

AFSPC establishes National Security Space Institute, Colorado Springs, Colo. ... NSSI serves as DOD's primary center for space education and training ... Incorporates Space Operations School formerly run by Space Warfare Center, Schriever AFB, Colo.

Oct. 1

"Navy Fence" network of nine antenna sites that identify satellites passing over the

contiguous US becomes "Air Force Fence" ... Operated by AFSPC's 20th Space Control Squadron, Det. 1, located at Naval Network and Space Operations Command, Dahlgren, Va.

Oct. 4

Air Force Col. Gordon L. Cooper Jr. (Ret.), youngest of NASA's seven original Mercury astronauts, dies at home in Ventura, Calif., at age 77.

Oct. 7

AFSPC officials unveil new single space badge, replacing current space and missile functional badge and "pocket rocket" missile operator's badge.

Nov. 6

A Boeing Delta II launched by AFSPC operators at Cape Canaveral boosts a Lockheed Martin-built GPS satellite into orbit to replace one of the satellites in the GPS constellation.

Dec. 10

Missile Defense Agency places interceptor at Vandenberg AFB, Calif. ... Part of MDA network of interceptors—six previously installed at Ft. Greely, Alaska. System developed to protect against ballistic missile attack.

Dec. 21

Boeing achieves first flight of its new Delta IV heavy lift rocket.

Feb. 3, 2005

Crews at Cape Canaveral launch last of Lockheed Martin's Atlas III rockets ... Boosts NRO satellite into orbit.

Feb. 11

Air Force space operators at Vandenberg take delivery of first Atlas V launcher.

March 25

Peter B. Teets, acting Secretary of the Air Force, resigns ... Had served as undersecretary of the Air Force, director of the NRO, and DOD executive agent for space since late 2001.

April 11

An Orbital Sciences Minotaur rocket boosts a microsatellite into polar orbit from Vandenberg ... Weighing only 220 pounds, and self-maneuvering, XSS-11 will rendezvous with a satellite and conduct standoff inspection and circumnavigation, among other capabilities.

April 26

USAF announces consolidation of ASPC's Space Warfare Center and Air Combat Command's Air Warfare Center to shed artificial distinction between airpower and space power ... New organization dubbed Air Force Warfare Center ... Located at Nellis AFB, Nev. ... Assigned to ACC.

April 29

Space operators at Cape Canaveral conclude 40-year history with launch of facility's last Titan IVB expendable launch vehicle.

May 2

Boeing and Lockheed Martin join forces to supply evolved expendable launch vehicle services for government payloads ... Move will reduce cost by combining launch support for Boeing's Delta IV and Lockheed's Atlas V EELVs.

June 29

Northrop Grumman completes delta preliminary design review, a major milestone for NPOESS program.

Space and Missile Badges

CURRENT



Space Badge



Astronaut

HISTORICAL



Space/Missile Badge



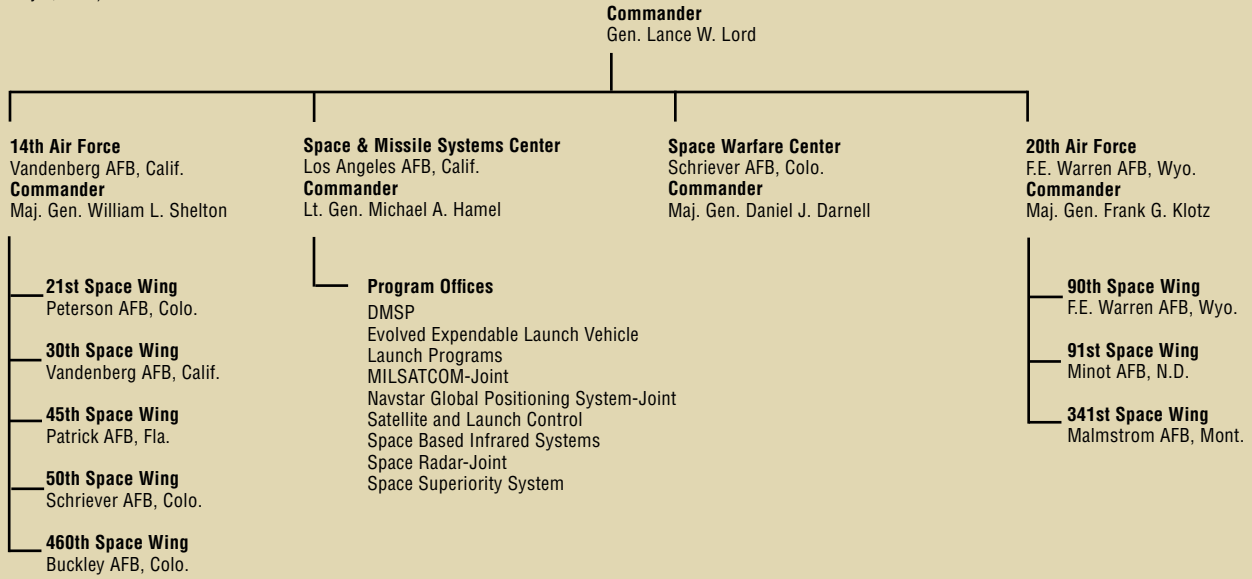
Missile Badge



Missile Badge With Operations Designator

Air Force Space Command, Peterson AFB, Colo.

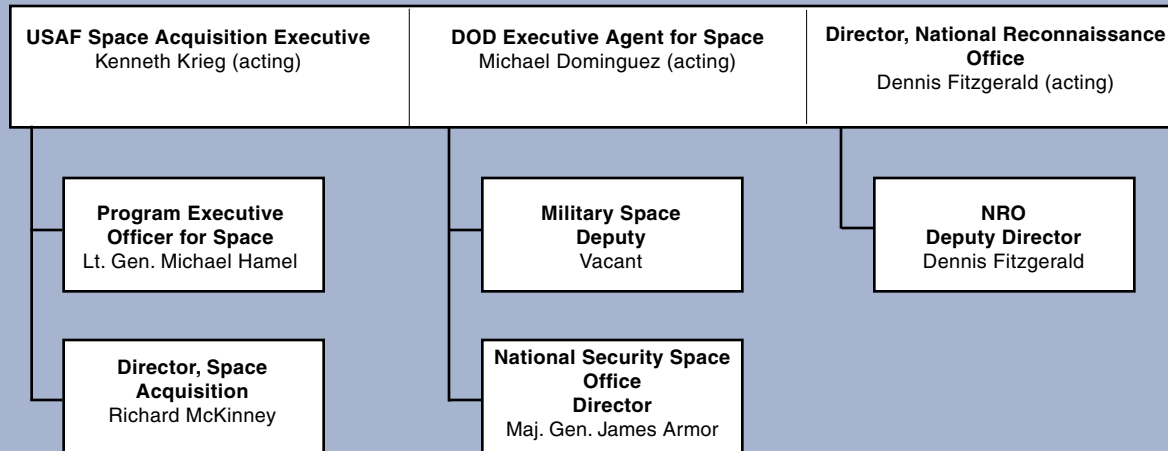
(As of July 1, 2005)



Air Force Space Bases, Stations, and Space Surveillance Network

Map by Zaur Eylanbekov

USAF Elements in National Security Space



Space Leaders

(As of July 9, 2005. A = Acting)

US Space Command

Gen. Robert T. Herres	Sept. 23, 1985	Feb. 5, 1987
Gen. John L. Piotrowski	Feb. 6, 1987	March 30, 1990
Gen. Donald J. Kutyna	April 1, 1990	June 30, 1992
Gen. Charles A. Horner	June 30, 1992	Sept. 12, 1994
Gen. Joseph W. Ashy	Sept. 13, 1994	Aug. 26, 1996
Gen. Howell M. Estes III	Aug. 27, 1996	Aug. 13, 1998
Gen. Richard B. Myers	Aug. 14, 1998	Feb. 22, 2000
Gen. Ralph E. Eberhart	Feb. 22, 2000	Oct. 1, 2002

US Strategic Command

Adm. James O. Ellis Jr.	Oct. 1, 2002	July 9, 2004
Gen. James E. Cartwright, USMC	July 9, 2004	

US Space Command was inactivated Oct. 1, 2002, and its mission transferred to US Strategic Command.

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	Feb. 22, 2000
Gen. Ralph E. Eberhart	Feb. 22, 2000	April 19, 2002
Gen. Lance W. Lord	April 19, 2002	

Army Space & Missile Defense Command

Lt. Gen. John F. Wall	July 1, 1985	May 24, 1988
Brig. Gen. R.L. Stewart (A)	May 24, 1988	July 11, 1988
Lt. Gen. Robert D. Hammond	July 11, 1988	June 30, 1992
B.Gen. W.J. Schumacher (A)	June 30, 1992	July 31, 1992
Lt. Gen. Donald M. Lionetti	Aug. 24, 1992	Sept. 6, 1994
Lt. Gen. Jay M. Garner	Sept. 6, 1994	Oct. 7, 1996
Lt. Gen. Edward G. Anderson III	Oct. 7, 1996	Aug. 6, 1998
Col. Stephen W. Flohr (A)	Aug. 6, 1998	Oct. 1, 1998
Lt. Gen. John Costello	Oct. 1, 1998	March 28, 2001
Brig. Gen. J.M. Urias (A)	March 28, 2001	April 30, 2001
Lt. Gen. J.M. Cosumano Jr.	April 30, 2001	Dec. 16, 2003
Lt. Gen. Larry J. Dodgen	Dec. 16, 2003	

Army Space and Missile Defense Command was the Army Strategic Defense Command until August 1992 and the Army Space and Strategic Defense Command until October 1997.

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
Charles W. Cook (A)	April 7, 1977	Aug. 3, 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
Jimmie D. Hill (A)	March 5, 1993	May 19, 1994
Jeffrey K. Harris	May 19, 1994	Feb. 26, 1996
Keith R. Hall (A)	Feb. 27, 1996	March 27, 1997
Keith R. Hall	March 28, 1997	Dec. 13, 2001
Peter B. Teets	Dec. 13, 2001	March 25, 2005
Dennis D. Fitzgerald (A)	March 25, 2005	

Naval Space Command

RAAdm. Richard H. Truly	Oct. 1, 1983	Feb. 28, 1986
Col. R.L. Phillips, USMC (A)	March 1, 1986	April 30, 1986
RAAdm. D. Bruce Cargill	April 30, 1986	Oct. 24, 1986
RAAdm. Richard C. Macke	Oct. 24, 1986	March 21, 1988
RAAdm. David E. Frost	March 21, 1988	April 2, 1990
Col. C.R. Geiger, USMC (A)	April 2, 1990	May 31, 1990
RAAdm. L.E. Allen Jr.	May 31, 1990	Aug. 12, 1991
RAAdm. Herbert A. Browne Jr.	Aug. 12, 1991	Oct. 28, 1993
RAAdm. Leonard N. Oden	Oct. 28, 1993	Jan. 31, 1994
RAAdm. Lyle G. Bien	Jan. 31, 1994	Dec. 13, 1994
RAAdm. Phillip S. Anselmo	Dec. 13, 1994	April 18, 1995
RAAdm. Katharine L. Laughton	April 18, 1995	Feb. 28, 1997
RAAdm. Patrick D. Moneymaker	Feb. 28, 1997	Sept. 10, 1998
Col. M.M. Henderson, USMC (A)	Sept. 10, 1998	Oct. 1, 1998
RAAdm. Thomas E. Zelbor	Oct. 1, 1998	June 8, 2000
RAAdm. J.J. Quinn	June 8, 2000	March 31, 2001
RAAdm. Richard J. Mauldin	March 31, 2001	Dec. 10, 2001
RAAdm. John P. Cryer	Dec. 10, 2001	July 12, 2002

Naval Network & Space Operations Command

RAAdm. John P. Cryer	July 12, 2002	Feb. 3, 2005
RAAdm. Gerald R. Beaman	Feb. 3, 2005	

Naval Space Command and Naval Network Operations Command merged July 12, 2002.

Major Military Commands With Space Functions

The Unified Command

US Strategic Command

Headquarters: Offutt AFB, Neb.
Established: June 1, 1992
Cmdr.: Gen. J.E. Cartwright, USMC

MISSIONS

Establish and provide full-spectrum global strike and coordinated space and information operations capabilities
Deliver operational space support and integrated missile defense
Provide global C4ISR and specialized joint planning expertise

The Service Components

Air Force Space Command

Headquarters: Peterson AFB, Colo.
Established: Sept. 1, 1982
Cmdr.: Gen. Lance W. Lord

MISSIONS

Operate and test USAF ICBM forces for STRATCOM; missile-warning radars, sensors, and satellites; national space launch facilities and operational boosters; worldwide space surveillance radars and optical systems; worldwide space environmental systems
Provide command and control for DOD satellites; ballistic missile warning to NORAD and STRATCOM; space weather support to entire DOD
Track space debris
Develop tactics, techniques, and procedures to integrate space capabilities with air, land, and sea capabilities
Produce and acquire advanced space systems

Naval Network & Space Operations Command

Headquarters: Dahlgren, Va.
Established: July 11, 2002
Cmdr.: RAdm. Gerald R. Beaman

MISSIONS

Operate and maintain the Navy's space and global telecommunications systems and services
Support warfighting operations and command and control of naval forces
Promote innovative technological solutions to warfighting requirements

US Military Payloads by Mission, 1958-2004

(Orbital only)

Applications	350
Communications	126
Weather	44
Navigation	94
Launch vehicle/spacecraft tests	3
Other military	83
Weapons-Related Activities	46
SDI tests	11
Antisatellite targets	2
Antisatellite interceptors	33
Reconnaissance	436
Photographic/radar imaging	250
Electronic intelligence	49
Ocean surveillance	46
Nuclear detection	12
Radar calibration	40
Early warning	39
Total	832

Major US Agencies With Roles in Space

Central Intelligence Agency

Headquarters: McLean, Va.
Established: 1947
Director: Porter J. Goss

Mission

Provide national security intelligence to senior US policy-makers

Direct Space Role

Support the National Reconnaissance Office in designing, building, and operating satellite reconnaissance systems

National Geospatial-Intelligence Agency

Headquarters: Bethesda, Md.
Established: Nov. 24, 2003
Director: James R. Clapper Jr.

Mission

Provide geospatial intelligence (analysis and depiction of Earth's physical features and geographic references) to aid national security operations

Formerly National Imagery and Mapping Agency (NIMA).

National Reconnaissance Office

Headquarters: Chantilly, Va.
Established: September 1961
Director: Dennis D. Fitzgerald (acting)

Mission

Design, build, and operate reconnaissance satellites
Acquire innovative technology
Provide systems engineering
Support monitoring of arms control agreements, military activities, natural disasters, and other worldwide events of interest to the US

National Security Agency

Headquarters: Ft. Meade, Md.
Established: 1952
Director: William Black (acting)

Mission

Protect US communications
Produce foreign signals intelligence information

Army Space & Missile Defense Command

Headquarters: Arlington, Va.
Established: Oct. 1, 1997
Cmdr.: Lt. Gen. Larry J. Dodgen

MISSIONS

Manage Army space and information operations and global strike, integrated missile defense, and C4ISR capabilities

Provide worldwide space support, including employment of satellite communications and theater missile warning to warfighters

Oversee Army space and missile R&D and development of Army space doctrine and concepts

AFSPC Personnel Deployed by Unified Command

Total deployed **729**

USCENTCOM	630
USEUCOM	14
USJFCOM	0
USNORTHCOM	37
USSOUTHCOM	44
USSOCOM	0
USPACOM	4
USTRANSCOM	0

Western and Southern Europe

Germany	6
UK	0
Italy	3
Turkey	0
Spain	1
Other countries	4

East Asia and Pacific

Japan/Okinawa	0
South Korea	0
Other countries	4

Africa, Near East, South Asia

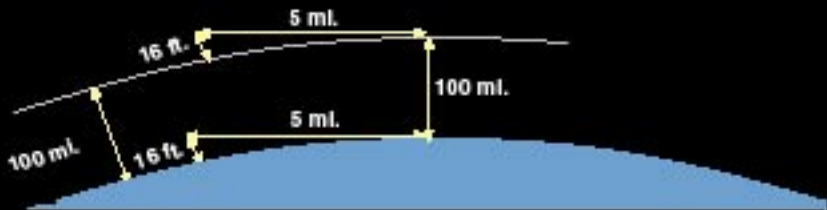
Saudi Arabia	1
Egypt	0
Other countries	629

Western hemisphere

Canada	0
Other countries	81

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 one G. 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.

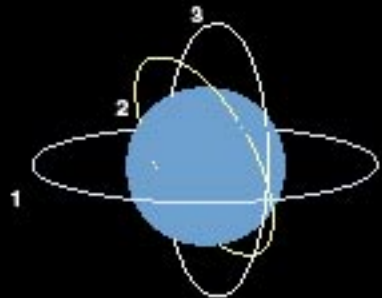
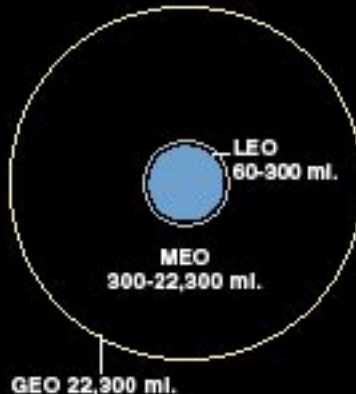


Orbital Altitude

- 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 Military/Civil Launches

(As of Dec. 31, 2004)

Year	Military	Civil	Total	Year	Military	Civil	Total	Year	Military	Civil	Total	Year	Military	Civil	Total
1958	0	7	7	1970	18	11	29	1982	6	12	18	1994	11	15	26
1959	6	5	11	1971	16	16	32	1983	8	14	22	1995	9	18	27
1960	11	5	16	1972	14	17	31	1984	11	11	22	1996	11	22	33
1961	19	10	29	1973	11	12	23	1985	4	13	17	1997	9	28	37
1962	32	20	52	1974	8	16	24	1986	4	2	6	1998	5	29	34
1963	25	13	38	1975	9	19	28	1987	6	2	8	1999	7	23	30
1964	33	24	57	1976	11	15	26	1988	8	4	12	2000	11	17	28
1965	34	29	63	1977	10	14	24	1989	11	7	18	2001	7	14	21
1966	35	38	73	1978	14	18	32	1990	11	16	27	2002	1	16	17
1967	29	29	58	1979	8	8	16	1991	6	12	18	2003	11	16	27
1968	23	22	45	1980	8	5	13	1992	11	17	28	2004	5	12	17
1969	17	23	40	1981	7	11	18	1993	12	11	23	Total	583	718	1,301

Data changes in prior years reflect recategorization from civil to military launches.

Sites for Space Launches, 1957-Present

As of Dec. 31, 2004

Launch Site	Operator	Total Launches
Plesetsk	Russia	1,547
Tyuratam/Baikonur, Kazakhstan	Russia	1,221
Vandenberg AFB, Calif.	US	629
Cape Canaveral AFS, Fla.	US	612
Kourou, French Guiana	ESA	173
JFK Space Center, Fla.	US	134
Kapustin Yar	Russia	101
Xichang	China	39
Tanegashima	Japan	37
Shuang Cheng-tsu/Jiuquan	China	34
Kagoshima	Japan	30
Wallops Flight Facility, Va.	US	31
Taiyuan	China	21
Edwards AFB, Calif.	US	20
Sriharikota	India	19
Pacific Ocean Platform	Sea Launch	14
Indian Ocean Platform	US	9
Palmachim	Israel	6
Hammaguir, Algeria	France	4
Svobodny	Russia	4
Woomera, Australia	Australia	4
Kodiak, Alaska	US	3
Alcantara	Brazil	1
Barents Sea	Russia	1
Kwajalein, Marshall Islands	US	1
Musudan ri	North Korea	1
Tennerife, Canary Islands	US	1
Total		4,697

What's Up There

As of May 31, 2005

Country Organization	Payloads in Orbit			Total
	Satellites	Space Probes	Debris	
Russia*	1,358	35	2,672	4,065
US	920	54	2,977	3,951
People's Republic of China	47	0	305	352
France	42	0	294	336
Japan	86	7	54	147
India	30	0	107	137
European Space Agency	34	5	32	71
Intl. Telecom Sat. Org.	61	0	0	61
Globalstar	52	0	0	52
Orbcomm	35	0	0	35
European Telecom Sat. Org.	26	0	0	26
Canada	22	0	1	23
Germany	20	2	1	23
United Kingdom	22	0	1	23
Sea Launch	1	0	13	14
Italy	11	0	2	13
Luxembourg	13	0	0	13
Australia	9	0	2	11
Brazil	10	0	0	10
Intl. Maritime Sat. Org.	10	0	0	10
Sweden	10	0	0	10
Argentina	9	0	0	9
Indonesia	9	0	0	9
NATO	8	0	0	8
South Korea	8	0	0	8
Spain	8	0	0	8
Arab Sat. Comm. Org.	7	0	0	7
Mexico	6	0	0	6
Saudi Arabia	6	0	0	6
Czech Republic	5	0	0	5
Israel	5	0	0	5
Netherlands	5	0	0	5
Turkey	5	0	0	5
Other**	42	3	0	45
Total	2,942	106	6,461	9,509

* Russia includes Commonwealth of Independent States (CIS) and former Soviet Union.

** Other refers to countries or organizations that have placed fewer than five objects in space.

US Satellites Placed in Orbit/Deep Space

(As of Dec. 31, 2004)

Year	Military	Civil*	Total	Year	Military	Civil*	Total	Year	Military	Civil*	Total	Year	Military	Civil*	Total
1958	0	7	7	1970	23	8	31	1982	8	9	17	1994	18	19	37
1959	6	5	11	1971	26	18	44	1983	16	12	28	1995	15	24	39
1960	12	5	17	1972	18	14	32	1984	17	16	33	1996	16	24	40
1961	20	12	32	1973	14	10	24	1985	13	17	30	1997	10	82	92
1962	35	20	55	1974	11	8	19	1986	7	4	11	1998	7	90	97
1963	33	22	55	1975	12	16	28	1987	10	1	11	1999	8	73	81
1964	44	25	69	1976	17	12	29	1988	11	9	20	2000	12	40	52
1965	49	39	88	1977	14	6	20	1989	15	9	24	2001	8	24	32
1966	52	47	99	1978	16	17	33	1990	22	16	38	2002	2	25	27
1967	51	34	85	1979	10	7	17	1991	17	18	35	2003	11	12	23
1968	35	26	61	1980	12	4	16	1992	12	17	29	2004	5	12	17
1969	32	27	59	1981	7	10	17	1993	12	18	30	Total	821	970	1,791

*Includes some military payloads.

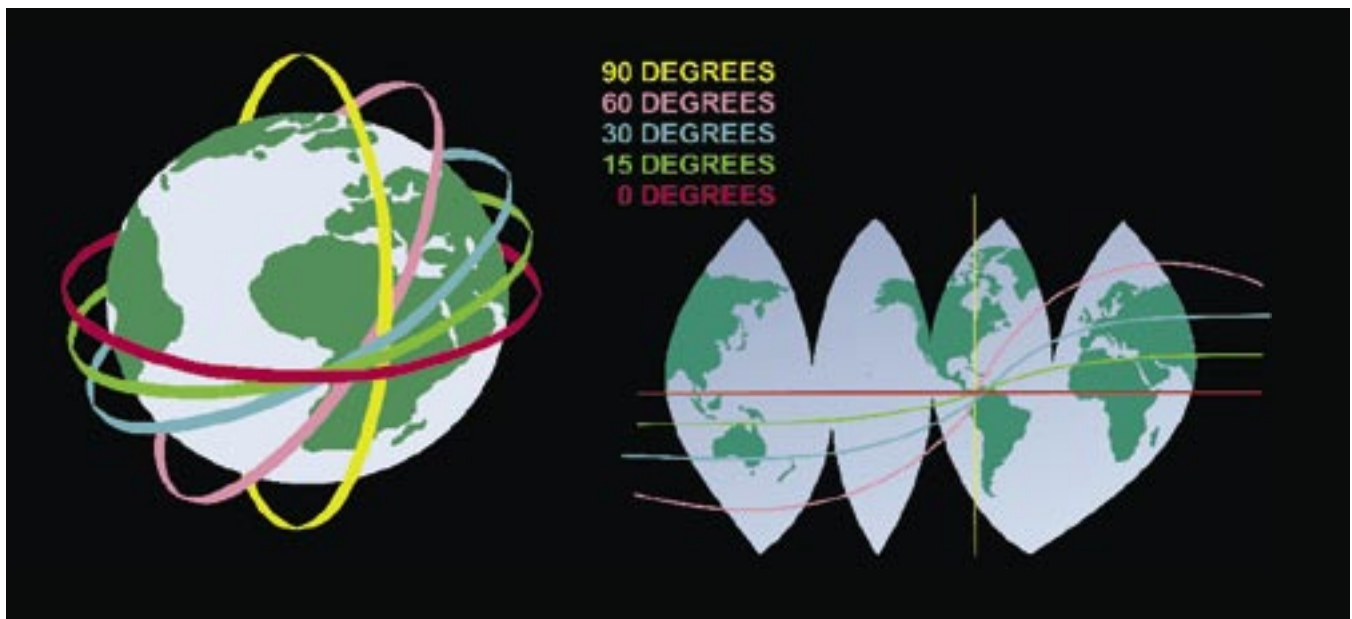
Air Force Personnel in Space

As of May 1, 2005

	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
Active Duty Air Force	23,214	22,224	21,049	19,198	18,201	17,337	17,004	19,064	19,495	19,862
Selected Guard and Reserve										
Air National Guard	0	0	0	285	285	354	354	519	519	649
Air Force Reserve Command	308	336	435	508	629	699	705	847	987	1,024
Total Guard and Reserve	308	336	435	793	914	1,053	1,059	1,366	1,506	1,673
Direct-hire Civilian	4,971	4,758	4,740	4,354	4,140	4,351	4,665	6,325	6,333	6,396

Satellite Inclination

Inclination is the angle between the Earth's equatorial plane and a satellite's orbital plane. A satellite at the wrong inclination—passing over the wrong spot on Earth—may hinder its ability to perform its mission.



DOD image

US Space Launch Sites

Alaska Spaceport

Location: 57.5° N, 153° W.

Type: Commercial.

Mission/operations: Polar and near-polar launches of communications, remote sensing, and scientific satellites up to 8,000 pounds.

Operator: Alaska Aerospace Development Corp.

Launches: Eight.

Launch vehicles: Athena I, suborbital.

History: Established in 1998; funded through AADC.

Cape Canaveral AFS, Fla.

Location: 28.5° N, 80° W.

Type: Military, civil, commercial.

Mission/operations: Geosynchronous launches for civil, military, and commercial missions and military ballistic missile tests.

Operator: USAF.

Launches: 612 (from 1957).

Launch vehicles: Athena I, II; Atlas II, III, V; Delta II, III, IV; Titan IV.

History: Designated in 1950 Operating Sub-Division #1; changed to Cape Canaveral Auxiliary AFB, then Cape Canaveral Missile Test Annex, Cape Kennedy Air Force Station, Cape Canaveral Air Force Station, Cape Canaveral Air Station, and, in 2000, back to Cape Canaveral AFS.

Florida Space Authority

Location: 28.5° N, 80° W.

Type: Civil, commercial.

Mission/operations: Florida, through FSA, developed, financed, or owns infrastructure at launch complexes 46 and 47 and manages a multiuser launch control facility, space experiments research and processing laboratory, and other facilities.

Operator: FSA.

Launches: 4.

Launch vehicles: Athena I, II; Super Loki;

Terrier; Viper.

History: Established in 1989.

John F. Kennedy Space Center, Fla.

Location: 28° N, 80° W.

Type: Civil, commercial, military.

Mission/operations: Primary space shuttle facility.

Operator: NASA.

Launches: 134.

Launch vehicles: Pegasus, space shuttle, Taurus.

History: NASA acquired land in 1962; by 1967, Complex 39 was operational; modified in 1970s to accommodate space shuttle program.

Mid-Atlantic Regional Spaceport

Location: 38° N, 76° W.

Type: Civil, commercial.

Mission/operations: Maryland and Virginia cooperative. Launches to inclined and sun-synchronous orbits; recovery support for ballistic and guided re-entry vehicles; vehicle and payload storage and processing facilities; two commercial pads; suborbital launch rails for civil, commercial, and military scientific missions.

Operator: Virginia Commercial Spaceflight Authority.

Launches: 13 (since 1995).

Launch vehicles: Athena I, II; Black Brant; Falcon; Lockheed Martin HYSR; Minotaur; Orion; Pegasus; Taurus; Terrier.

Sea Launch

Location: Equator, 154° W, Pacific Ocean.

Type: Commercial.

Mission/operations: Heavy lift GTO launch services. Owned by an international partnership: Boeing, RSC Energia, Kvaerner ASA, and SDO Yuzhnoye/PO Yuzhmash.

Operators: Partners listed above.

Launches: 14.

Launch vehicles: Zenit-3SL.

History: Established in April 1995; demonstration launch March 1999.

Spaceport Systems Intl., L.P.

Location: 34.70° N, 120.46° W.

Type: Commercial, civil, military.

Mission/operations: Polar and near-polar LEO launches; small to medium launch vehicles up to one million pound thrust; payload processing facility for small and heavy satellites.

Operator: Spaceport Systems Intl.

Launches: Three.

Launch vehicles: Minotaur.

History: SSI, a limited partnership formed by ITT and California Commercial Spaceport, Inc., achieved full operational status of the spaceport in May 1999.

Vandenberg AFB, Calif.

Location: 35° N, 121° W.

Type: Military, civil, commercial.

Mission/operations: Launches into polar orbits; sole site for test launches of USAF ICBM fleet; basic support for R&D tests for DOD, USAF, and NASA space, ballistic missile, and aeronautical systems; facilities and essential services for more than 60 aerospace contractors.

Operator: USAF.

Launches: 629.

Launch vehicles: Athena I; Atlas II, III, V; Delta II, III, IV; Pegasus; Taurus; Titan II, IV.

History: Originally Army's Camp Cooke; turned over to USAF 1957; renamed Vandenberg Oct. 4, 1958.

Wallops Flight Facility, Va.

Location: 38° N, 76° W.

Type: Civil, military, commercial.

Mission/operations: Suborbital research launch site.

Operator: NASA

Launches: 30.

Launch vehicles: 14 suborbital sounding rockets.

History: Established in 1945, it is one of world's oldest launch sites.

AFSPC Squadrons by Mission Type

(As of Sept. 30, 2004)

Component	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04
Active force										
ICBM	14	14	14	14	14	14	14	14	11	11
Space operations	10	10	10	10	10	8	8	8	8	9
Space communications	1	1	1	1	1	1	1	0	0	6
Space warning	8	8	8	8	8	7	7	8	8	6
Space surveillance	6	6	6	6	6	6	4	3	3	3
Space launch	5	5	5	5	5	3	3	3	4	4
Range	2	2	2	2	2	2	2	2	2	2
Space control	1	1	1	1	1	2	3	3	3	3
Space aggressor	0	0	0	0	0	0	0	0	1	1
Total active force	47	47	47	47	47	43	42	41	40	45
Reserve forces										
ANG										
Space operations	0	0	0	0	0	0	1	1	3	4
Space warning	0	0	0	0	0	0	1	1	1	2
AFRC										
Space operations	3	3	3	3	3	4	4	4	4	4
Space warning	1	1	1	1	1	1	1	1	1	1
Space aggressor	0	0	0	0	0	0	0	0	1	1
Total reserve forces	4	4	4	4	4	5	7	7	10	10
Total all components	51	51	51	51	51	48	49	48	50	67

The Constellations

Multiple satellites working in groups to perform a single mission can provide greater coverage than a single satellite, enabling global coverage or increasing timeliness of coverage.

Navigation constellations provide simultaneous signals from multiple satellites to a location on the ground.

Communications constellations ensure at least one satellite is in line of sight of both ends of the communications link.

Weather and reconnaissance constellations generally contain both high and low altitude systems.

Some **surveillance** systems need continuous access to areas of interest, calling for high altitude, long dwell time orbits.

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 extended 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

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
1999	3	19
2000	5	32
2001	6	38
2002	5	34
2003	1	7
2004	0	0
Total	143	736



Navigation



Communications



Reconnaissance



Intelligence and Weather



Surveillance

DOD image

**Athena II****Atlas V****Delta II**

Major US Launchers in US Military Use

Athena I

Function: lift low to medium weights.
 First launch: Aug. 22, 1997.
 Launch site: CCAFS, 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: 1,750 lb to LEO.

Athena II

Function: lift low to medium weights.
 First launch: Jan. 6, 1998.
 Launch site: CCAFS, 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: 4,350 lb to LEO.

Atlas V

Function: lift medium to heavy weights.
 Variants: 400 and 500 series.
 First launch: Aug. 21, 2002.
 Launch site: CCAFS, VAFB.
 Contractor: Lockheed Martin.
 Stages: two.
 Propulsion: (400 and 500 series) stage 1: one RD AMROSS LLC RD-180 engine with two chambers, 860,200 lb thrust; stage 2: Centaur, one or two Pratt&Whitney RL10A-4-2 engines, 22,221-44,442 lb thrust. Strap-on solid rocket boosters, up to three (400), up to five (500).
 Dimensions: (stage 1) length 106.5 ft, max

body diameter 12.5 ft; (stage 2) length 41.6 ft, max body diameter 10 ft.
 Weight: 741,061 lb-1.2 million lb.
 Payload: (400 series) 27,558 lb to LEO, 10,913-16,843 to GTO; (500 series) 22,707-45,238 lb to LEO, 8,752-19,114 lb to GTO. (500 series supports 16.5 ft diameter payload fairing.)

Delta II

Function: lift medium weights.
 First launch: Feb. 14, 1989.
 Launch site: CCAFS, 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, max body diameter 8 ft.
 Weight: 511,190 lb.
 Payload: 11,330 lb to LEO.

Delta IV

Function: lift medium to heavy weights.
 Variants: Medium, Medium-Plus, and Heavy.
 First launch: Nov. 20, 2002.
 Launch site: CCAFS, VAFB.
 Contractor: Boeing.
 Stages: two.
 Propulsion: stage 1 (Rocketdyne RS-68 (Heavy, two additional core engines), 650,000 lb thrust; stage 2 (Medium), P&W RL10B-2, 1,750 lb thrust.
 Dimensions: (core booster, all versions) length 125 ft, max body diameter 16.7 ft.
 Weight: (Medium) 64,719 lb; (heavy) 196,688 lb.
 Payload max: (Medium) 2,508 lb to GEO, 20,075 lb to LEO; (Medium-Plus) 4,489-

6,142 lb to GEO, 27,116-30,575 lb to GEO; (Heavy) 13,837 lb to GEO, 48,264 lb to LEO. (Heavy supports 16.6 ft diameter payload fairing.)

EELV

Function: lift medium to heavy weights.
 Note: Atlas V and Delta IV (see individual entries) are participating in USAF's evolved expendable launch vehicle (EELV) modernization program to cut launch costs by 25 to 50 percent. These systems will replace Delta II, Atlas II, Titan II, and Titan IV launch vehicles.

Pegasus

Function: lift low weights.
 Variants: Standard and XL.
 First launch: (Standard) April 5, 1990; (XL) June 27, 1994.
 Launch site: dropped from L-1011 aircraft.
 Contractor: Orbital Sciences, Alliant.
 Stages: three.
 Propulsion: (XL) (all Alliant Techsystems) stage 1, 109,400 lb thrust; stage 2, 27,600 lb thrust; stage 3, 7,800 lb thrust.
 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 GEO.

Space shuttle

Function: lift heavy weights.
 First launch: April 12, 1981.
 Launch site: KSC.
 Contractor: Boeing (launch).
 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.

Boeing photo



Space shuttle

USAF photo



Taurus

USAF photo



Titan IVB

Taurus

Function: lift low weights.
Variants: Standard and XL.
First launch: March 13, 1994.
Launch site: CCAFS, VAFB, Wallops Island.
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 IVB

Function: lift heavy weights.
First launch: (IVB) Feb. 23, 1997.
Launch site: CCAFS, VAFB.
Contractor: Lockheed Martin.
Stages: two; may add Centaur or inertial upper stages (IUS).
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, max body diameter 10 ft.
Weight: 1.9 million lb.
Payload max: 47,800 lb to LEO.

Major Military Satellite Systems

Advanced Extremely High Frequency Satellite Communications System

Common name: AEHF
In brief: successor to Milstar, AEHF to provide assured strategic/tactical, worldwide C2 communications with at least 10 times the capacity of Milstar II but in a smaller package.
Function: EHF communications.
Operator: MILSATCOM JPO (acquisition); AFSPC.
First launch: April 2008, planned.
On orbit: three-five.
Orbit altitude: 22,300 miles.

Defense Meteorological Satellite Program

Common name: DMSP
In brief: satellites that collect air, land, sea, and space environmental data to support worldwide strategic and tactical military operations. Operational control transferred to NOAA in 1998; backup operation center at Schriever AFB, Colo., manned by Air Force Reserve Command personnel.
Function: environmental monitoring.
Operator: NPOESS Integrated Program Office.
First launch: May 23, 1962.
On orbit: two (primary).
Orbit altitude: approx 575 miles.

Defense Satellite Communications System III

Common name: DSCS
In brief: nuclear-hardened and jam-resistant spacecraft used to transmit high-priority C2 messages to battlefield commanders.
Function: SHF communications.
Operator: AFSPC.
First launch: October 1982.
On orbit: five (primary).
Orbit altitude: 22,000+ miles.

Defense Support Program

Common name: DSP
In brief: early warning spacecraft whose infrared sensors detect heat generated by

Major Military Satellite Systems, Continued

a missile or booster plume.

Function: strategic and tactical missile launch detection.

Operator: AFSPC.

First launch: November 1970.

On orbit: classified.

Orbit altitude: 22,000+ miles.

Enhanced Polar System

Common name: EPS

In brief: next generation polar communications to replace interim polar system (see Polar Military Satellite Communications, below), which provides only a fraction of the polar communications capability required by aircraft, submarines, and other forces operating in the high northern latitudes. Pre-acquisition, system definition, and risk reduction efforts start in Fiscal 2006.

Function: EHF communications.

Operator: MILSATCOM JPO (acquisition); AFSPC.

First launch: circa 2013.

On orbit: none.

Orbit altitude: 22,300+ miles.

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: Navy.

First launch: March 1998 (Phase 2 payload on UHF Follow-On and continued on Wideband Gap-filler).

On orbit: three.

Orbit altitude: 23,230 miles.

Global Positioning System

Common name: GPS

In brief: constellation of satellites used by military and civilians to determine a precise location and time anywhere on Earth. Block IIR began replacing older

GPS spacecraft in mid-1997; first modified Block IIR-M with military (M-code) on two channels launches in 2005. Next generation Block IIF with extended design life, faster processors, and new civil signal on third frequency launches in 2007. Generation after next GPS III with advanced antijam and higher quality data is slated for initial launch in 2013.

Function: worldwide navigation and precise time transfer.

Operator: AFSPC.

First launch: Feb. 22, 1978 (Block I).

On orbit: 28.

Orbit altitude: 12,600 miles.

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.

On orbit: five.

Orbit altitude: 22,300 miles.

Mobile User Objective System

(also known as Advanced Narrowband System)

Common name: MUOS

In brief: next generation narrowband UHF tactical communications satellite to replace the UHF Follow-On Satellite (see below at right). Concept study contracts awarded in 1999; production award to Lockheed Martin in Sept., 2004; initial launch in 2009.

Function: UHF tactical communications.

Operator: Navy.

First launch: 2009, planned.

On orbit: none.

Orbit altitude: 22,300 miles.

Polar Military Satellite Communications

(also known as Interim Polar and Adjunct Polar)

Common name: Polar MILSATCOM

In brief: USAF deployed a modified EHF

payload on a host polar-orbiting satellite to provide an interim solution to ensure warfighters have protected polar communications capability. Polars 2 and 3 slated for launch in 2005 and 2007, respectively.

Function: EHF polar communications.

Operator: Navy.

First launch: 1997.

On orbit: one.

Orbit altitude: 25,300 miles (apogee).

Space Based Infrared System High

Common name: SBIRS High

In brief: advanced surveillance system for missile warning, missile defense, battlespace characterization, and technical intelligence. System initially will complement, then replace, Defense Support Program spacecraft (see p. 57).

Function: infrared space surveillance.

Operator: AFSPC.

First launch: 2007, planned.

On orbit: none.

Orbit altitude: 22,300 miles.

Space Radar

Common name: SR

In brief: spaceborne capability, providing deep look, all weather, day and night forward presence and situation awareness for the Intelligence Community and joint warfighters.

Function: track moving ground targets.

Operator: AFSPC.

First launch: 2015, planned.

On orbit: none.

Orbit altitude: LEO.

Space Tracking and Surveillance System (formerly SBIRS Low)

Common name: STSS

In brief: infrared surveillance and tracking satellites to detect and track ballistic missiles from launch to impact. System is sensor component of layered ballistic missile defense system and will work with SBIRS High (see above).

Function: infrared surveillance.

Operator: MDA (acquisition); AFSPC.

First launch: 2007 for R&D, planned.

On orbit: none.

Transformational Satellite Communications System

Common name: TSAT

In brief: joint communications satellite being designed to provide Internet-like connectivity to warfighters. It will feature laser crosslink and greatly reduced transmission time to users on the ground. Intended to replace Advanced Extremely High Frequency system (see p. 57), it is slated for launch around 2012. Currently in design and risk-reduction phase.

Function: EHF communications.

Operator: MILSATCOM JPO (acquisition); AFSPC.

First launch: 2013, planned.

On orbit: none.

Orbit altitude: 22,300 miles.

UHF Follow-On Satellite

Common name: UFO

In brief: new generation satellites providing secure, antijam communications;

Boeing photo illustration



Global Positioning System

Major Military Satellite Systems, Continued

replaced FLTSATCOM satellites.

Function: UHF and EHF communications.

Operator: Navy.

First launch: March 25, 1993.

Constellation: four primary, four redundant.

On orbit: nine.

Orbit altitude: 22,300 miles.

Wideband Gap-filler System

Common name: WGS

In brief: high data rate satellite broadcast system (primarily commercial product) meant to bridge the communications gap between current systems—DSCS and GBS—and TSAT (see p. 57 and 58).

Function: wideband communications and point-to-point service (Ka-band and X-band frequencies).

Operator: AFSPC.

First launch: 2006, planned.

On orbit: none.

Orbit altitude: Geostationary.

Dark and Spooky

A number of intelligence satellites are operated by US agencies in cooperation with the military. The missions and, espe-

cially, the capabilities are closely guarded secrets.

Most of the names of satellites, such as White Cloud (ocean reconnaissance),

Aquacade (electronic ferret), and Trumpet (Sigint), are essentially open secrets but cannot be confirmed by the Intelligence Community.



Wideband Gap-filler System

Major Civilian Satellites in US Military Use

Geostationary Operational Environmental Satellite

Common name: GOES

In brief: in equatorial orbit 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, with on-orbit spare.

Orbit altitude: 22,300 miles.

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: 878 miles.

Ikonos

Common name: Ikonos

In brief: one-meter resolution Earth imaging. Slated for shutdown in 2007.

Function: remote sensing.

Operator: Space Imaging, Inc.

First launch: Sept. 24, 1999.

Constellation: one.

Orbit altitude: 423 miles.

Inmarsat

Common name: Inmarsat

In brief: peacetime mobile communications services, primarily by US Navy.

Function: communications.

Operator: International Maritime Satellite Organization.

First launch: February 1982 (first lease), Oct. 30, 1990 (first launch).

Constellation: nine.

Orbit altitude: 22,300 miles.

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: 20.

Orbit altitude: 22,300 miles.

Iridium

Common name: Iridium

In brief: voice, fax, data transmission.

Function: handheld, mobile communications.

Operator: Iridium L.L.C.

First Launch: May 5, 1997.

Constellation: 66 (six on-orbit spares).

Orbit: 485 miles.

Landsat

Common name: Landsat

In brief: imagery use includes mapping and planning for tactical operations.

Function: remote sensing.

Operator: NASA.

First launch: July 23, 1972.

Constellation: one.

Orbit altitude: 438 miles (polar).

National Polar-orbiting Operational Environmental Satellite System

Common name: NPOESS

In brief: advanced joint civil-military polar environmental satellite that provides weather, atmosphere, ocean, land, and near-space data. Managed by tri-agency (DOD, Department of Commerce, and NASA) integrated program office. Designed to replace USAF's DMSP and NOAA's Polar-orbiting Operational Environmental Satellite (POES) (see p. 61).

Function: worldwide environmental forecasting.

Operator: IPO (AFSPC for acquisition and launch; NOAA for operations).

First launch: 2008, planned.

Constellation: two.

On orbit: none.

Orbit altitude: 22,300 miles.

Orbcomm

Common name: Orbcomm

In brief: potential military use under study in Joint Interoperability Warfighter Program.

Function: mobile communications.

Operator: Orbcomm Global L.P.

First launch: April 1995.

Constellation: 35.

Orbit altitude: 500-1,200 miles.

Pan Am Sat

Common name: Pan Am Sat

In brief: routine communications providing telephone, TV, radio, and data.

Function: communications.

Major Civilian Satellites in US Military Use, Continued

Operator: Pan Am Sat.
First launch: 1983.
Constellation: 21.
Orbit altitude: 22,300 miles.

Polar-orbiting Operational Environmental Satellite

(also known as NOAA-K, L, and M before launch; NOAA-15, 16, and 17, respectively, once on orbit).

Common name: POES

In brief: two advanced third generation environmental satellites (one morning orbit and one afternoon orbit) provide longer-term weather updates for all areas of the world. Final two spacecraft in this series are NOAA-N (slated for launch in 2005) and N Prime. To be replaced by NPOESS.

Function: extended weather forecasting.
Operator: NOAA (on-orbit); NASA (launch).

First launch: May 13, 1998 (NOAA-15).

Constellation: two.

Orbit altitude: 517 miles.

Quickbird 2

Common name: Quickbird 2
In brief: high-resolution imagery for mapping, military surveillance, weather research, and other uses.

Function: remote sensing.

Operator: DigitalGlobe.

First launch: Oct. 18, 2001.

Constellation: one.

Orbit altitude: 279 miles.

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.

Telstar

Common name: Telstar

In brief: commercial satellite-based, rooftop-to-rooftop communications for US

Army and other DOD agencies.

Function: communications.

Operator: Loral Skynet.

First launch: November 1994.

Constellation: three.

Orbit altitude: 22,300 miles.

Tracking and Data Relay Satellite System

Common name: TDRSS

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: six.

Orbit altitude: 22,300 miles.

Major US Military Ground-based Space Surveillance Systems

Air Force Space Surveillance System

Common name: Air Force Fence

In brief: continuous wave radars located across the southern US to track man-made objects in Earth orbit.

Function: space surveillance.

Operator: AFSPC.

Operational: March 31, 1959 (US Navy).

Unit location: Dahlgren, Va. (command & control); receivers in Arkansas, California, Georgia, Mississippi, and New Mexico; transmitters in Alabama, Arizona, and Texas.

Components: One command & control center, six receiver sites, and three transmitter sites.

AN/FPS-85 Phased-Array Radar

Common name: Eglin radar

In brief: active phased-array radar used in all weather to track man-made objects in Earth orbit.

Function: space surveillance.

Operator: AFSPC.

Operational: Jan. 29, 1969.

Unit location: Eglin AFB, Fla.

Components: AN/FPS-85 solid-state phased-array radar.

Ballistic Missile Early Warning System

Common name: BMEWS

In brief: phased-array radar used for tactical warning and attack assessment and tracking Earth-orbiting satellites.

Function: ballistic missile attack and space surveillance.

Operator: AFSPC.

Operational: 1959 (Trinidad, British West Indies); July 1, 1961 (Clear AFS, Alaska).

Unit location: Clear AFS, Alaska; RAF Fylingdales, UK; Thule AB, Greenland.

Components: (Clear AFS) AN/FPS-120

solid-state phased-array radar (SSPAR) with two faces; computers for radar control and data processing.

Ground-based Electro-optical Deep Space Surveillance

Common name: GEODSS

In brief: optical system that tracks objects such as Earth-orbiting satellites in deep space.

Function: space surveillance.

Operator: AFSPC.

Operational: June 30, 1982.

Unit location: Det. 1, Socorro, N.M.; Det. 2, Diego Garcia, Indian Ocean; Det. 3, Maui, Hawaii.

Components: three telescopes, low-light-level EO cameras, and high-speed computers.

Moron Optical Space Surveillance

Common name: MOSS

In brief: optical system that tracks objects such as Earth-orbiting satellites in deep space.

Function: space surveillance.

Operator: AFSPC.

Operational: June 1998.

Unit location: Det. 4, Moron, Spain.

Components: optical telescope and high-speed computers.

Pave Phased-Array Warning System

Common Name: Pave PAWS

In brief: Phased-array radar used to detect and track sea-launched and inter-continental ballistic missiles, as well as Earth-orbiting satellites.

Function: missile warning and space surveillance.

Operator: AFSPC.

Operational: August 1980.

Unit location: Beale AFB, Calif.; Cape Cod AFS, Mass.

Components: AN/FPS-115 phased-array radar; computers for radar control and data processing.

Perimeter Acquisition Radar Attack Characterization System

Common name: PARCS

In brief: Provides ICBM and SLBM warning and space surveillance of Earth-orbiting satellites in deep space.

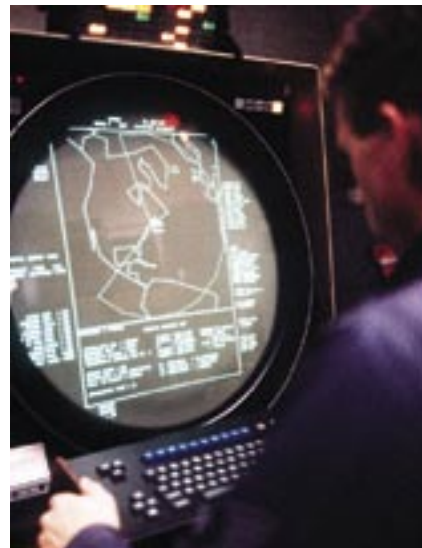
Function: ballistic missile warning and space surveillance.

Operator: AFSPC.

Operational: 1977.

Unit location: Cavalier AFS, N.D.

Components: One AN-FPQ-16 single-faced, phased-array radar.



SSgt. Paul Brawner studies a radar screen for the AN-FPS-115 Pave PAWS phased-array warning system radar.

USAF photo by CMSgt. Don Sutherland

Milestones in Military Space

March 22, 1946. JPL-Ordnance WAC, first US rocket to leave Earth's atmosphere, reaches 50-mile height after launch from White Sands Proving Ground, N.M.

Oct. 4, 1957. USSR launches Sputnik 1, first man-made satellite, into Earth orbit.

Jan. 31, 1958. US launches its first satellite, Explorer 1.

Dec. 18, 1958. Project Score spacecraft conducts first US active communication from space.

Feb. 28, 1959. USAF successfully launches Discoverer 1 (of then-classified Corona program), world's first polar-orbiting satellite, from Vandenberg AFB, Calif.

April 6, 1959. The first military unit to be charged with conducting military satellite operations, USAF's 6594th Test Wing, is established at Palo Alto, Calif.

April 13, 1959. Air Force Thor/Agena A boosts into orbit Discoverer 2 satellite, first satellite to be stabilized in orbit in all three axes, to be maneuvered on command from Earth, to separate a re-entry vehicle on command, and to send its re-entry vehicle back to Earth.

Aug. 7, 1959. Explorer 6 spacecraft transmits first television pictures from space.

June 22, 1960. US launches Galactic Radiation and Background (GRAB) satellite, the nation's first successful reconnaissance spacecraft. It collects electronic intelligence (Elint) from Soviet air defense radars.

Aug. 18, 1960. Discoverer/Corona satellite takes first image of Soviet territory ever snapped from space.

April 12, 1961. Soviet cosmonaut Yuri Gagarin pilots Vostok 1 through nearly

one orbit to become first human in space.

May 5, 1961. 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.

Feb. 20, 1962. Project Mercury astronaut Lt. Col. John H. Glenn Jr., aboard Friendship 7 capsule, completes first US manned orbital flight.

May 15, 1963. USAF Maj. L. Gordon Cooper Jr. makes nearly 22 orbits in spacecraft Faith 7, becoming the first American astronaut to perform an entirely manual re-entry.

Oct. 17, 1963. Vela Hotel satellite performs first space-based detection of nuclear explosion.

March 18, 1965. First space walk conducted by Alexei Leonov from Soviet Voskhod 2.

June 4, 1965. Gemini 4 astronaut USAF Maj. Edward H. White II performs first American space walk.

June 18, 1965. USAF accepts Titan III, first Air Force vehicle specifically designed and developed as a military space booster.

Dec. 15, 1965. Crews of Gemini 6 and Gemini 7 rendezvous in space. Navy Capt. Walter M. Schirra and USAF Maj. Thomas P. Stafford in Gemini 6 maneuver to within a foot of Gemini 7 crew.

Jan. 25, 1967. Soviets complete first successful fractional orbital bombardment system test, deorbiting Kosmos 139 satellite re-entry vehicle to an impact point within Soviet Union.

July 3-4, 1967. Air Force, Army, and Navy

conduct first satellite-based tactical communications.

Oct. 20, 1968. Soviet Kosmos 249 spacecraft carries out first co-orbital antisatellite test, exploding Kosmos 248 target satellite into cloud of debris.

July 20, 1969. At 10:56 p.m. EDT, Apollo 11 astronaut Neil A. Armstrong puts his foot on the surface of the moon, becoming the first human to do so.

November 1970. USAF launches first classified Defense Support Program satellite, whose infrared sensors provide space-based early warning of missile launches.

April 19, 1971. First space station, Salyut 1, goes aloft.

Feb. 22, 1978. Atlas booster carries first Global Positioning System Block I satellite into orbit, paving way for a revolution in civil, commercial, and military navigation.

April 12-14, 1981. Space shuttle performs its first orbital flight and becomes first reusable spacecraft to land back on Earth.

Aug. 30, 1983. USAF Col. Guion S. Bluford Jr. becomes the first African American in space, as a mission specialist aboard *Challenger*.

Sept. 13, 1985. First US antisatellite intercept test destroys Solwind scientific satellite by air-launched weapon.

Jan. 17, 1991. What USAF calls "the first space war," Operation Desert Storm, opens with air attacks.

Jan. 13, 1993. USAF Maj. Susan J. Helms, flying aboard space shuttle *Endeavour*, becomes first US military woman in space.

Major Space Treaties and Laws

Long Title	Nickname	Entry Into Force
Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water	Nuclear Test Ban	Oct. 10, 1963
Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies	Outer Space Treaty	Oct. 10, 1967
Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space	Rescue Agreement	Dec. 3, 1968
Convention on International Liability for Damage Caused by Space Objects	Liability Convention	Sept. 1, 1972
Convention on Registration of Objects Launched Into Outer Space	Registration Convention	Sept. 15, 1976
Agreement Governing the Activities of States on the Moon and Other Celestial Bodies	Moon Agreement	July 11, 1984

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Space Terms

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

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 non-circular, closed spaceflight path.

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

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).

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 and GEO.

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).

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.

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.

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.

Acknowledgements

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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.