THE SPACE BRIEFING BOOK

2025

A REFERENCE GUIDE TO MODERN SPACE ACTIVITIES

SPACE FOUNDATION

INTRODUCTION

Space impacts every facet of life. Business, governance, security, education, manufacturing, healthcare, communication, and more all rely on space-based infrastructure and the technologies derived from exploring and operating in space. With rapidly expanding space access, miniaturization of technology, growing scientific knowledge, and the enduring human desire to explore our universe, there has never been a more exciting or important time with space.

The Space Briefing Book is a primer and reference guide on the entities, laws and regulations, technologies, and factors in modern space operations. It is designed to support and inform legislators and staff, policymakers, journalists, and others whose work holds a nexus to space.

The global space economy was worth $570 billion in 2023*, and in the balance sheet of national priorities, space is a critical investment. It yields cascading dividends for job creation, technology transfer, expanded entrepreneurship, international partnerships, shared research and development, and much more. Indeed, space exploration and operation deliver wider opportunity than any effort on the planet—or beyond it.

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SPACE FOUNDATION

*Space Foundation releases a new global space economy number toward the end of the 2nd quarter of each calendar year. Please see The Space Report (www.thespacereport.org) for updates.

All of the details and information presented within this document are as of January 2025. For the most up to date information, visit www.spacefoundation.org/briefingbook

Composite X-ray image of the star-forming region called 30 Doradus using X-ray data from NASA's Chandra X-ray Observatory with optical data from NASA's Hubble Space Telescope and radio data from the Atacama Large Millimeter/submillimeter Array. *NASA*

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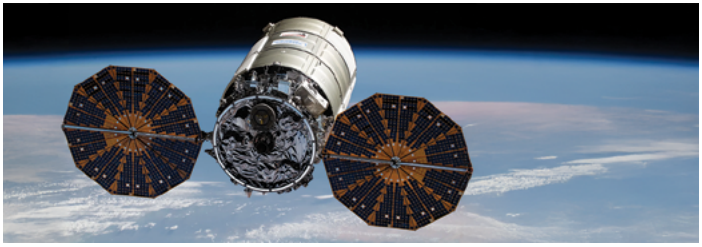
Launch sites in Cape Canaveral, Florida

MODERN SPACE CRAFT

CST-100 STARLINER

Boeing

boeing.com



CYGNUS

Northrop Grumman

northropgrumman.com

DRAGON

SpaceX

spacex.com

DREAM CHASER

Sierra Space

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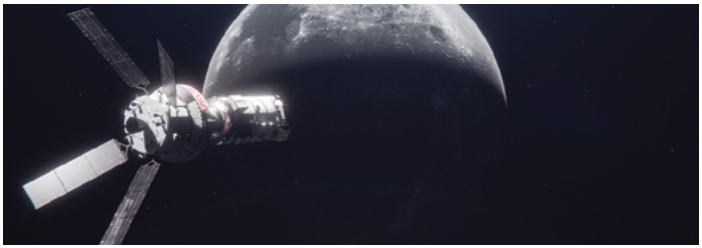
NEW SHEPARD

Blue Origin

blueorigin.com

Photo credit: Blue Origin



ORION

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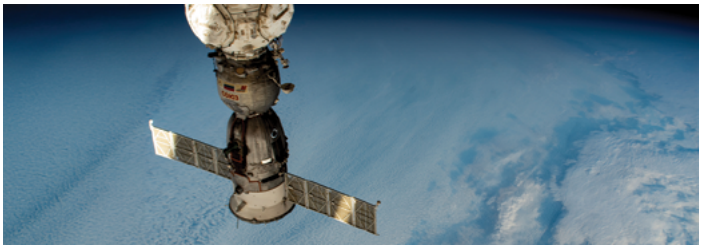


SOYUZ

Energia

VSS UNITY

Virgin Galactic

virgingalactic.com

Image: Virgin Galactic

COMMERCIAL SPACE STATIONS

Multiple commercial space stations are planned for deployment 2025-2028.

SATELLITES

Satellites are foundational components of modern society, permitting communications, global positioning, Earth and solar system study, and a range of other activities.

SATELLITE APPLICATIONS

EARTH OBSERVATION

Remote sensing satellites are used to study the Earth, such as weather events, ecological trends, and ocean temperatures. Collected data has valuable applications in areas such as precision agriculture, disaster and emergency management, and urban development.

SPACE SCIENCE

Satellites are used to study the many celestial bodies in the solar system. To date, artificial satellites have orbited many significant planets and moons in our solar system, as well as numerous smaller objects like dwarf planets, asteroids, and comets.

RECONNAISSANCE

Similar to Earth science uses, reconnaissance or intelligence satellites employ a suite of sensors and communications tools, deployed and used by government agencies for defense or intelligence purposes, including early missile detection and emergency broadcasts.

COMMUNICATIONS

Most of the satellites in orbit are used for relaying communications around the Earth's curve.

POSITION, NAVIGATION AND TIMING (PNT)

Navigation satellites deliver geospatial positioning, identifying a single point on the ground by its latitude, longitude, and altitude.

BROADBAND INTERNET

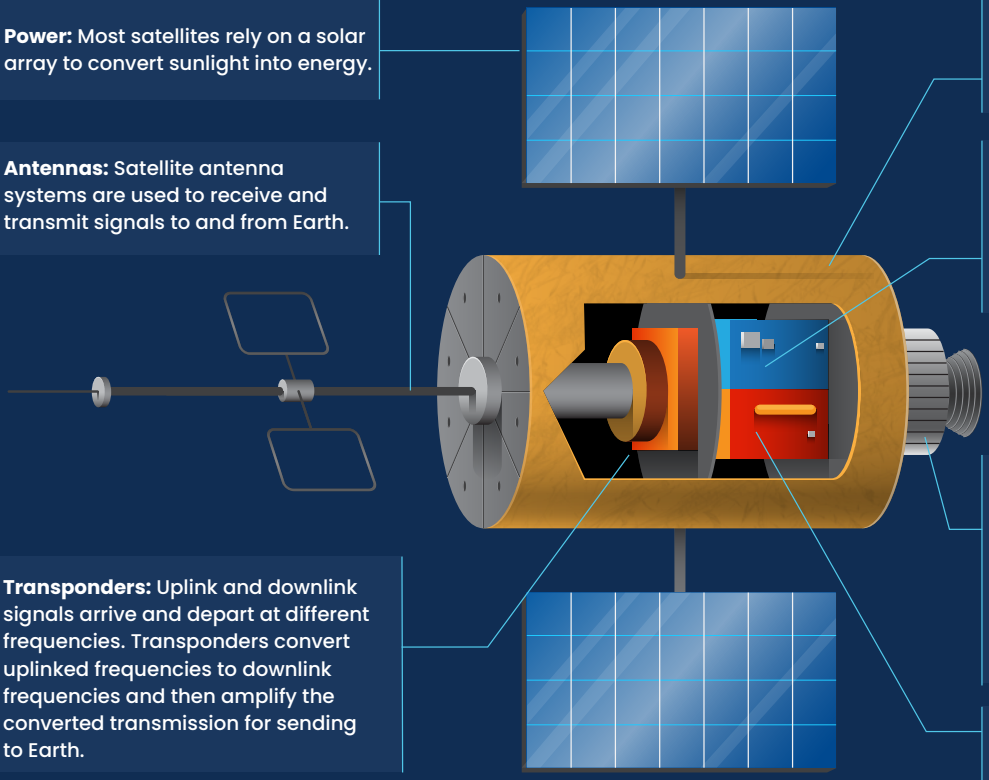
Satellite constellations (typically in LEO) provide high-speed internet connectivity to terrestrial devices and systems.

SATELLITE PARTS AND SYSTEMS

Power: Most satellites rely on a solar array to convert sunlight into energy.

Antennas: Satellite antenna systems are used to receive and transmit signals to and from Earth.

Transponders: Uplink and downlink signals arrive and depart at different frequencies. Transponders convert uplinked frequencies to downlink frequencies and then amplify the converted transmission for sending to Earth.



Housing: Housing is constructed from strong materials that can withstand the harsh space environment.

Command and Data Handling: The operational heart of a satellite, command and control systems monitor every aspect of the satellite and receive commands from Earth for operation.

Guidance and Stabilization: Sensors monitor the satellite's position to ensure it remains in the correct orbit and is oriented toward the correct target. If necessary, thrusters and other maneuvers allow a satellite to fine-tune its position and orientation.

Thermal Control: Guards satellite equipment against extreme changes in temperature.

THE INTERNATIONAL SPACE STATION (ISS)

ISS AT A GLANCE:

Orbital speed: 17,150 mph

Mass: 50 tons

Pressurized Module Length: 73 meters (more than 60% the length of a football field)

Pressurized Module Volume: 906 cubic meters (equivalent to a Boeing 747)

Solar Array Power Generation: 75+ kilowatts (enough to power 40 homes)

Participating Countries: United States, Russia, Canada, Japan, Brazil, and the 11 European countries in the ESA

COMPONENTS OF THE ISS

Remote Manipulator System: Robotic arm built by Canada, "Canadarm 2."

Columbus Laboratory: ESA-built and operated research module, shared with NASA.

Japanese Experiment Module: JAXA's module is the biggest on the ISS, supporting two research facilities and a robotic arm.

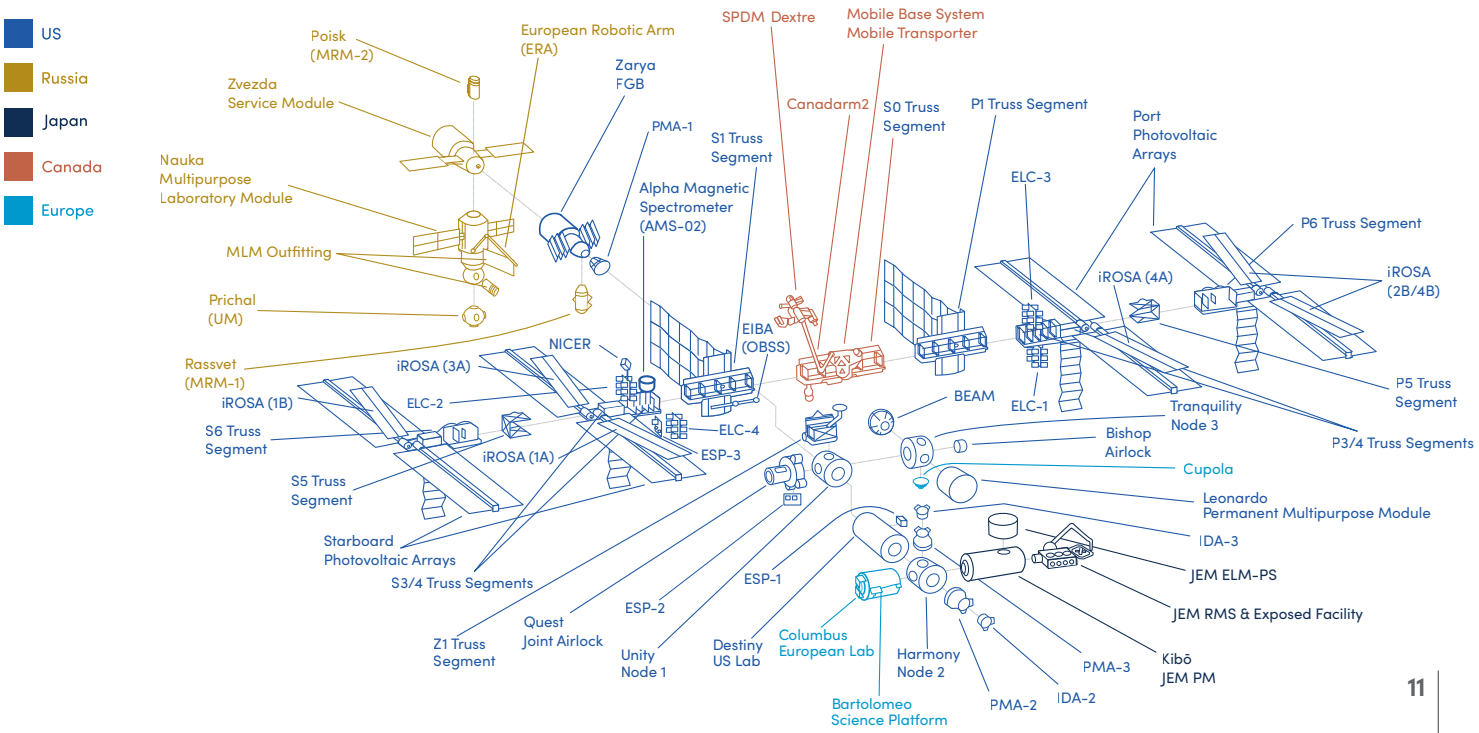
Zarya and Zvezda Modules: Beginning with the launch of the Functional Cargo Block module (Zarya) in 1998, the Russian Space Program also added a life-support system service module (Zvezda) in 2000.

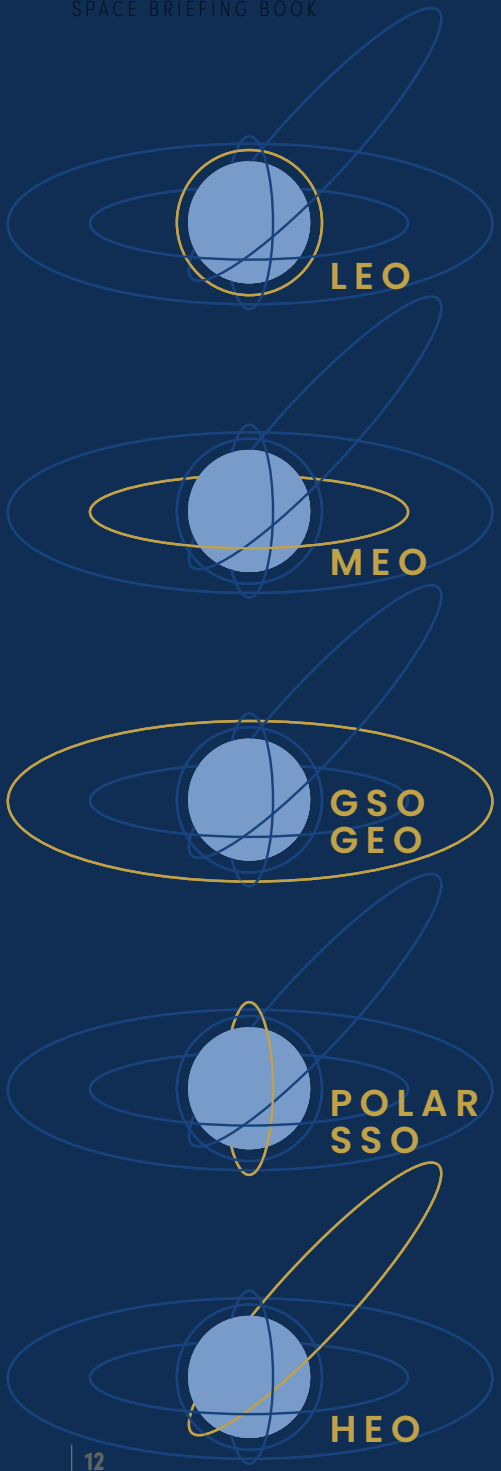
Unity, Destiny, Harmony and Tranquility Modules: Beginning with the launch of Unity in 1998, the United States also added the U.S. Lab (Destiny) in 2001 and the Node 2 utility hub (Harmony) in 2007. NASA installed the Tranquility module in 2010.

Cupola: The observatory module with seven windows for direct observation of the station and Earth built by ESA in 2010.

Solar Array: The United States built eight solar array wings, each 34 meters long (more than two city buses end to end) and generating as much as 120 kilowatts.

External Active Thermal Control: Controls the ISS's temperature by using cooling and heat-absorbing technologies.





ORBITS

LOW EARTH ORBIT (LEO)

LEO is commonly used for communication and remote sensing satellite systems, as well as the International Space Station (ISS) and Hubble Space Telescope.

MEDIUM EARTH ORBIT (MEO)

MEO is commonly used for navigation systems, including the U.S. Global Positioning System (GPS).

GEOSYNCHRONOUS ORBIT (GSO) AND GEOSTATIONARY ORBIT (GEO)

Objects in GSO have an orbital speed that matches the Earth's rotation, yielding a consistent position over a single longitude. GEO is a kind of GSO. It matches the planet's rotation, but GEO objects only orbit Earth's equator, and from the ground perspective, they appear in a fixed position in the sky. GSO and GEO are used for telecommunications and Earth observation.

POLAR ORBIT AND SUN-SYNCHRONOUS ORBIT (SSO)

Within 30 degrees of the Earth's poles, the polar orbit is used for satellites providing reconnaissance, weather tracking, measuring atmospheric conditions, and long-term Earth observation.

SSO is a type of polar orbit, wherein objects are synchronous with the sun, such that they pass over an Earth region at the same local time every day.

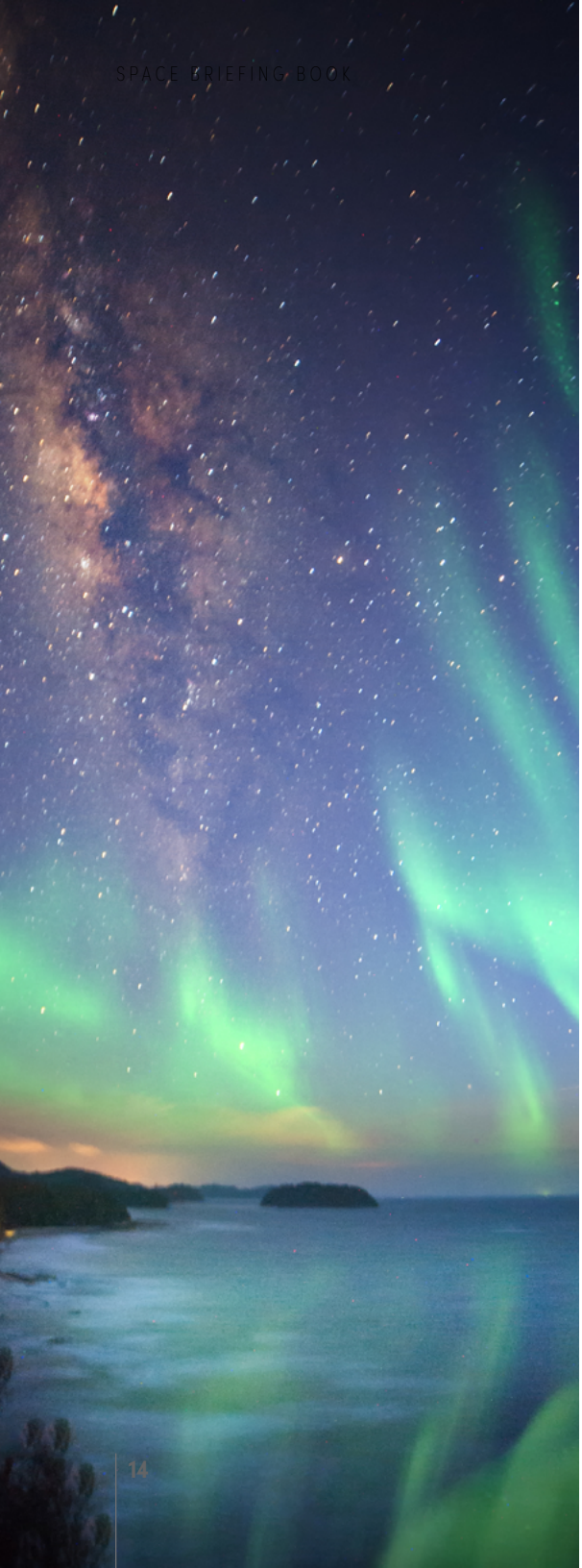
HIGHLY ELLIPTICAL ORBIT (HEO)

An HEO is oblong, with one end nearer the Earth and other more distant. Satellites in HEO are suited for communications, satellite radio, remote sensing, and other applications.

SPACE PROGRAMS AROUND THE WORLD

More than 70 countries around the world are developing and expanding their national space programs. Some of the most prominent global space agencies include:

- 1958 National Aeronautics and Space Administration (NASA), est. 1958
- 1961 National Centre for Space Studies (CNES), est. 1961
- 1969 German Aerospace Center (DLR), est. 1969
- 1969 Indian Space Research Organisation (ISRO), est. 1969
- 1972 Swedish National Space Agency (SNSA), est. 1972
- 1975 European Space Agency (ESA), est. 1975
- 1983 Israel Space Agency (ISA), est. 1983
- 1988 Italian Space Agency (ASI), est. 1988
- 1990 Canadian Space Agency (CSA), est. 1990
- 1992 Roscosmos State Corporation for Space Activities, est. 1992
- 1993 China National Space Administration (CNSA), est. 1993
- 1994 Brazilian Space Agency (AEB), est. 1994
- 2003 Japan Aerospace Exploration Agency (JAXA), est. 2003
- 2004 Iranian Space Agency, est. 2004
- 2010 UK Space Agency, est. 2010
- 2014 United Arab Emirates Space Agency, est. 2014
- 2016 New Zealand Space Agency, est. 2016
- 2018 Australian Space Agency (ASA), est. 2018
- 2024 Korea AeroSpace Administration (KASA), est. 2024



SPACE ENVIRONMENT

SPACE WEATHER

Space weather refers to conditions in space caused by solar activity. As the sun emits electromagnetic radiation, it creates "solar wind," which flows out into the solar system. Space weather can impact space- and ground-based infrastructure and technologies, such as radio communications and electrical grids.

The solar cycle is the Sun's natural 11-year rhythm. During solar minimum, sunspots and solar flares are typically fewer and smaller, while during the solar maximum, sunspots are larger and more frequent.

PLANETARY DEFENSE

Earth is susceptible to collisions with asteroids and comets. While most asteroids burn up in the atmosphere or land with minimal consequence, there are potentially hazardous asteroids (PHA) and Near-Earth Comets (NEC) that could cause catastrophic outcomes for life on Earth if they impacted the planet. In 2022, NASA's Double Asteroid Redirection Test (DART) mission crashed a spacecraft into asteroid Dimorphos to test a method of asteroid deflection through kinetic impact. The test showed the asteroid's orbit was successfully changed by the impact.

SPACE SECTORS

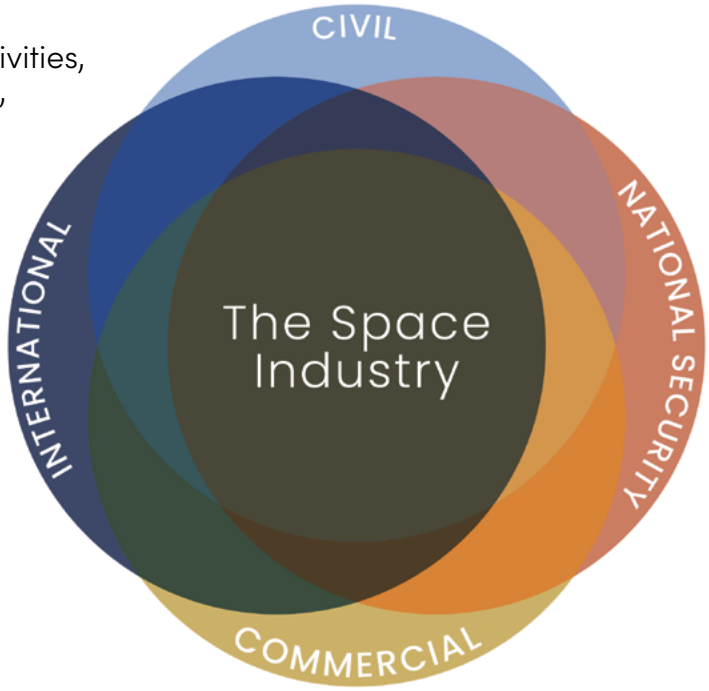
Space endeavors are grouped into sectors: civil, national security (i.e., defense and intelligence), international, and commercial. While each sector operates with its own goals and assets, there is growing overlap and integration across sectors, particularly as they all rely on a common space industrial base, workforce, and infrastructure.

INTERNATIONAL

Space is a global enterprise with more countries' economies, infrastructures, and national security operations dependent on it. Partnerships, alliances and dialogues of multiple forms and designs are evolving as demands change.

CIVIL

Non-defense-related government space activities, including launching and managing satellites, conducting research, and exploring the solar system. In the United States, nearly all civil space missions are managed or run by NASA and NOAA.



NATIONAL SECURITY

The defense and intelligence sectors are commonly considered together as a "national security" sector. The U.S. Department of Defense oversees space missions in support of military operations, and several agencies in the U.S. intelligence community are involved in operating space assets for intelligence purposes to support military and law enforcement operations.

COMMERCIAL

All space-related endeavors—including goods, services and activities—provided by private sector enterprises with the legal capacity to offer their products to nongovernmental customers. Commercial space efforts range from satellite communication to space tourism.

THE UNITED STATES GOVERNMENT'S ROLE IN SPACE

There are numerous agencies, departments, and organizations throughout the U.S. government with a role in space operation, policy, funding, and other matters.

EXECUTIVE OFFICE

Executive Office of the President — The U.S. President, informed by Executive Office advisors, committees, and councils, develops space policy that sets government priorities and goals and guides legislative action to fund the policy objectives.

Office of Science and Technology Policy (OSTP) — As part of the Executive Branch, OSTP advises the President on matters relating to science and technology, including development and innovation, impact on the nation and the economy, and how the federal government sets science and technology-related policies.

National Security Council — Advises the President on developing policies related to national security and foreign affairs. As it can concern military and intelligence matters, projecting and protecting a national presence in space is within the Council's purview.

National Space Council* — Chaired by the Vice President, the Council includes the participation of departments with a space nexus (e.g., NASA, State, Commerce) to develop and advise on policies that impact U.S. space innovation, exploration, and dominance.

*Pending new Administration decision.

CONGRESSIONAL OVERSIGHT COMMITTEES

U.S. House Committee on Appropriations | ***Subcommittee on Commerce, Justice, Science, and Related Agencies*** — Appropriates budgets for space and science programs, including NASA, NOAA, and the NSF.

U.S. House Committee on Science, Space and Technology | ***Subcommittee on Space and Aeronautics*** — Oversees programs and policies relating to space exploration and national space policy, including NASA and NOAA.

U.S. House Armed Services Committee | ***House Subcommittee on Strategic Forces*** — Oversees programs and policies relating to strategic deterrence, missile defense, and space.

U.S. House Permanent Select Committee on Intelligence — Oversees programs and policies relating to the U.S. intelligence community.

U.S. Senate Committee on Appropriations | ***Subcommittee on Commerce, Justice, Science, and Related Agencies*** — Appropriates budgets for space and science programs, including NASA, NOAA, and the NSF.

U.S. Senate Committee on Commerce, Science and Transportation | ***Subcommittee on Space and Science*** — Oversees agencies engaged in space activity, including NASA, the FAA Office of Commercial Space Transportation, the Commerce Department Office of Space Commerce, and other organizations.

U.S. Senate Armed Services Committee | ***Subcommittee on Strategic Forces*** — Oversees programs and policies relating to nuclear and strategic forces, space programs, and ballistic missile defense.

U.S. Senate Select Committee on Intelligence — Oversees programs and policies relating to the U.S. Intelligence Community.

DEFENSE AND INTELLIGENCE AGENCIES

United States Space Force (USSF) — A branch of the armed services established in 2019, U.S. Space Force organizes, trains, and equips service members and presents those forces to U.S. Space Command and other Combatant Commands. While a separate branch of the military, it is organized under the Department of the Air Force, similarly to how the U.S. Marine Corps is organized under the Department of the Navy. As part of its capabilities, USSF manages space launch operations, holds command and control of all Department of Defense satellites, and controls ground- and space-based systems monitoring for ballistic missile launches, satellites, and space debris.

Space Development Agency — A unit in the USSF, the SDA designs and deploys the Proliferating Warfighter Space Architecture, a constellation of small satellites to support defense. The services delivered through the constellation include missile tracking, low-latency data transmission, and space-based battle management.

U.S. Space Command (SPACECOM) — A Combatant Command responsible for delivering space capabilities to joint and combined forces and protecting and defending the space domain. It is composed of six warfighting units:

Army Space and Missile Defense Command — Develops and provides space, missile defense, and high-altitude capabilities to the Army, joint force, and allies and partners.

Marine Corps Forces Space Command (MARFORSPACE) — Provides space operational support to the Fleet Marine Force while building a convergence capability to increase warfighter lethality.

Navy Space Command (NavSpace) — Responsible for Navy information network operations, offensive and defensive cyberspace operations, space operations, and signals intelligence.

Air Forces Space (AFSPACE) — Provides airpower expertise and advocacy to conduct operations in, from, and to space while integrating space power into the support of First Air Force's homeland defense mission.

U.S. Space Forces – Space (S4S) — Holds operational control of USSF forces and plans, integrates, and conducts space operations to deliver combat-relevant space effects.

Joint Functional Component Command for Missile Defense — Synchronizes missile defense planning, conducts global missile defense operations support, advises on missile defense capabilities, and provides global missile defense training.

Other defense and intelligence agencies involved in the U.S. national security space sector include:

Defense Advanced Research Projects Agency (DARPA) — The agency invests in breakthrough technologies for national security needs. DARPA's work includes exploring space technologies, such as the Experimental Spaceplane program.

Defense Intelligence Agency (DIA) — DIA provides defense intelligence to the military branches and the intelligence community. As a part of this, it identifies challenges, needs, and threats in space, and it operates the Missile and Space Intelligence Center, which provides intelligence assessments on foreign weapons systems.

Defense Innovation Unit (DIU) — DIU is focused on fielding and adopting commercial technology for military applications, as well as strengthening national security innovation through engagement with commercial technology sectors. It partners with DoD organizations to prototype and test technologies for operational defense needs.

Missile Defense Agency — A research, development, and acquisition agency within the Department of Defense charged with developing and fielding a ballistic missile defense system to detect and defend against enemy ballistic missiles. System components include ground-based interceptor missiles, warship-based interceptors, and the Terminal High Altitude Area Defense (THAAD) program.

National Geospatial-Intelligence Agency (NGA) — A combat support agency using satellite reconnaissance data to provide geospatial intelligence for military and other operations.

National Security Agency (NSA) — NSA is an intelligence agency that analyzes electronic signals and systems through data gathered, in part, by satellite reconnaissance, producing signals intelligence (SIGINT) regarding international terrorists and foreign powers, organizations, or people.

National Reconnaissance Office (NRO) — Procures and operates U.S. reconnaissance satellites in support of intelligence-related activities. It operates four primary types of satellite constellations: SIGINT (signals intelligence); GEOINT (geospatial intelligence); Communications Relay; and Reconnaissance.

CIVIL AGENCIES

National Aeronautics and Space Administration (NASA) — Founded in 1958, NASA is the primary space agency for the U.S. government. With its headquarters in Washington, DC, NASA's research, development, and operations are spread across centers around the country.

National Oceanic and Atmospheric Administration (NOAA) — NOAA is charged with studying Earth's climate, weather, and oceans, as well as how solar phenomena affect Earth. Among its space-related functions, NOAA manages the National Weather Service, remote-sensing satellite constellations, and the Space Weather Prediction Center.

Office of Space Commerce, Department of Commerce — The office is the primary agency responsible for space commerce policy activities in the Department of Commerce, fostering the growth and success of the U.S. commercial space industry.

Office of Space Affairs, Department of State — The Office of Space Affairs (formerly known as the Bureau of Oceans and International Environmental and Scientific Affairs—often referred to as "Oceans, Environment, and Science" or simply "OES") advances American space leadership by pursuing and maintaining a rules-based international framework for space commercialization and use. It also leads the U.S. delegation to the United Nations Committee on the Peaceful Uses of Outer Space.

Office of Commercial Space Transportation (AST), FAA — An office within the FAA, AST grants licenses and permits for launch/reentry vehicles and spaceports, sets insurance requirements for launch providers, and regulates commercial spacecraft design and operation to ensure the health and safety of humans onboard.

Space Bureau, Federal Communications Commission — The Bureau, established in 2023, leads policy and licensing for satellite and space-based communications and activities. It engages in rulemaking, helps space operators navigate regulatory processes, and is the FCC's organization for coordinating with other parts of the U.S. government on space policy.

U.S. SPACE POLICY

The efforts of U.S. space agencies, organizations, and businesses across all space sectors are guided, empowered, and sometimes restricted through federal law, presidential directives, executive orders, and regulations.

President Donald Trump signs Space Policy Directive - 1, directing NASA to return to the moon, alongside members of the Senate, Congress, NASA, and commercial space companies in the Roosevelt room of the White House in Washington, Monday, Dec. 11, 2017. *NASA/Aubrey Gemignani*

NOTABLE U.S. SPACE-RELATED LEGISLATION

Title 51 of the United States Code (USC) — USC Title 51 is a compilation of existing space-related laws organized into a topical space-specific section of the USC.

Communications Act of 1934 — Passed long before the first spaceflight, the Communications Act has been amended over time to govern requirements for commercial satellite operations, licensing, and coordination in the use of the radio spectrum.

National Aeronautics and Space Act of 1958 — President Dwight Eisenhower signed the act in 1958, which established NASA as well as U.S. objectives in space: expanding space knowledge; creating and improving space vehicles; studies of benefits from space operation; preserving the United States as a space leader; and sharing discoveries with defense agencies.

The Commercial Space Launch Act of 1984 — Originally passed in 1984 and since amended, the law grants the U.S. Department of Transportation regulatory oversight of commercial spaceflight, it indemnifies companies for large third-party damages, and it informs regulations for commercial human spaceflight.

Land Remote-Sensing Commercialization Act of 1984 — Passed in 1984, the law principally concerned transferring the U.S. government-owned Landsat satellite program to private industry, allowing companies to take over operation of the Earth-imaging satellite constellation.

NOTABLE U.S. SPACE-RELATED LEGISLATION (CONT)

Land Remote-Sensing Policy Act of 1992 — The 1992 law repealed the Land Remote-Sensing Commercialization Act, as transfer to the private sector of the U.S. government-owned Landsat proved problematic. The new law gave the Department of Commerce the power to license and regulate a U.S. commercial remote-sensing industry and to outsource the development of new Landsat components to the private sector.

U.S. Commercial Space Launch Competitiveness Act of 2015 — The law was designed to encourage commercial spaceflight and innovation by: postponing significant regulatory oversight of private spaceflight companies until 2023; extending the period during which the government indemnifies commercial spaceflight companies for third-party damages beyond the company's required liability insurance; and granting private companies the right to own resources collected in space, such as materials from asteroid mining.

Weather Research and Forecasting Innovation Act of 2017 — The law permits commercial weather satellites and allows NOAA to purchase weather data from commercial weather satellite constellations.

CHIPS and Science Act of 2022 — The act makes large, cross-cutting investments and incentivizes growth in American manufacturing and technology development. It also contains the 2022 NASA Authorization Act, which funded the Artemis missions, extended International Space Station operations through 2030, and created the Moon to Mars Program.

National Defense Authorization Act (annual) — Each year, Congress passes a law to reauthorize DoD budgets and spending, including for national security space activities and organizations. As of 2024, the NDAA has been passed annually for 63 consecutive years.

EXECUTIVE ORDERS

EO 13744 | ***Coordinating Efforts to Prepare the Nation for Space Weather Events (2016)*** — Establishes U.S. policy to prepare for space weather events to minimize the potential impact on the economy and society.

EO 13803 | ***Reviving the National Space Council (2017)*** — The National Space Council stopped operating in 1993. The executive order revived the Council and articulated its duties related to advising and assisting the President on space policy and strategy. It was amended in 2020 with EO 13906, changing some reporting requirements and council membership.

EO | ***Establishment of the United States Space Command (2018)*** — Establishes a U.S. Space Command as a functional Unified Combatant Command with general responsibilities of a Unified Combatant Command, space-related responsibilities previously assigned to U.S. Strategic Command, and responsibilities of Joint Force Provider and Joint Force Trainer for Space Operations Forces.

EO 13865 | ***Coordinating National Resilience to Electromagnetic Pulses (2019)*** — Directs the federal government to develop "sustainable, efficient and cost-effective approaches" to building national resilience to the impact from an electromagnetic pulse (EMP), including those caused by solar eruptions.

EO 13914 | ***Encouraging International Support for the Recovery and Use of Space Resources (2020)*** — Establishes U.S. policy to encourage international support for the public and private recovery and use of space resources, directs NASA and other federal agencies to negotiate joint statements and agreements in line with the U.S. policy, and notes that the UN Moon Agreement is neither effective nor necessary in promoting private sector participation in space activities.

EO 13972 | ***Promoting Small Modular Reactors for National Defense and Space Exploration*** — Sets a U.S. policy to promote nuclear reactor technology, including small modular reactors, for use in space exploration and national security space activity. It directs the Defense Secretary to implement a plan to demonstrate micro-reactor capabilities and directs the NASA Administrator to define requirements for using nuclear energy systems for space exploration.

EO 14056 | ***The National Space Council (2021)*** — Revokes and replaces EO 13803 (2017) and EO 13906 (2020), establishing updated details on council membership, duties, and responsibilities.

Secretary of Commerce Wilbur Ross, left, NASA Administrator Jim Bridenstine, center, and Commander, U.S. Strategic Command, General John Hyten testify before the House Subcommittee on Strategic Forces during a hearing on Space Situational Awareness: Whole of Government Perspectives on Roles and Responsibilities, Friday, June 22, 2018 at the Rayburn House Office Building in Washington. *NASA/Bill Ingalls*

REGULATIONS

Radio Frequency Regulation — The Federal Communications Commission (FCC) grants licenses for commercial satellite communication, dictating which band of the electromagnetic spectrum a satellite can use. Spectrum assignments are co-managed with the National Telecommunications and Information Administration.

CFR Title 14, Chapter III — The FAA's regulations on commercial spaceflight cover the "authorization and supervision" of any U.S. organization or citizen conducting space endeavors. It requires commercial missions to receive a license to launch (and re-enter), and it also requires licenses for commercial spaceports. It does not apply to government agencies, like NASA.

International Traffic in Arms Regulations (ITAR) — ITAR restricts the export of technology and data related to national security. In 2014, ITAR export restrictions were loosened for 36 countries and satellite components were largely moved to the Commercial Control List. The U.S. State Department's Directorate of Defense Trade Controls, Bureau of Political-Military Affairs, directs ITAR restrictions and licensing.

Export Administration Regulations (EAR) — The Department of Commerce's EAR regulates technologies and data whose commercial export could lead to military applications by other countries. The Commerce Control List details the technologies that require a license to be exported. In 2024, the Bureau of Industry and Security (BIS) released a final rule removing license requirements for the export of items involved in remote sensing or spacecraft assembly and servicing that are being exported to Australia, Canada, and the United Kingdom.

Licensing of Private Remote Sensing Space Systems — The Department of Commerce (through NOAA) grants licenses for private remote sensing systems. In 2020, the Commerce Department released updated regulations for the modern space ecosystem, adjusting and streamlining licensing processes for private remote sensing systems.

NATIONAL SPACE POLICY DIRECTIVES (SPDS)

SPD-1 | Reinvigorating America's Human Space Exploration Program (2017) — Amends Presidential Policy Directive-4 (2010), articulating a direct call for space missions beyond LEO, specifically to the Moon and eventually to Mars and other celestial bodies.

SPD-2 | Streamlining Regulations on Commercial Use of Space (2018) — Calls on Executive Branch agencies to review existing regulations and ensure rules are not duplicative while also promoting economic growth, advancing national security and foreign policy goals, and encouraging U.S. space commerce leadership.

SPD-3 | National Space Traffic Management Policy (2018) — Calls for a new method of space traffic management (STM) that: meets current and future risks; sets priorities for space situational awareness and STM innovation; aligns with national security priorities; and encourages U.S. commercial space growth.

SPD-4 | Establishment of the United States Space Force (2019) — Directs the Defense Department to develop a legislative proposal establishing a sixth branch of the U.S. Armed Forces, as well as establishing a U.S. Space Command.

SPD-5 | Cybersecurity Principles for Space Systems (2020) — Sets the U.S. policy that executive branch agencies foster and apply cybersecurity practices in government and commercial space activities to protect space assets and infrastructure from cyber threats.

SPD-6 | Memorandum on the National Strategy for Space Nuclear Power and Propulsion (2020) — Establishes the national strategy for developing and using nuclear power and propulsion (SNPP) systems (when appropriate) for scientific, exploratory, national security, and commercial space activity.

SPD-7 | The United States Space-Based Positioning, Navigation and Timing Policy (2021) — Sets actions and guidance for implementing U.S. space-based PNT programs and activities, including modernizing GPS, activities for protecting GPS, and initiatives with foreign PNT and foreign use of GPS.

INTERNATIONAL SPACE LAW

There are five international treaties underpinning space law, overseen by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS).

The Outer Space Treaty (October 10, 1967) | ***Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*** —The treaty is the foundation for international space law. The treaty presents principles for space exploration and operation. Signatory states: 115.

- Space activities are for the benefit of all states, and any country is free to explore orbit and beyond.
- There is no claim to sovereignty in space; no state can "own" space, the Moon or any other body.
- Weapons of mass destruction are forbidden in orbit and beyond, and the Moon, the planets, and other celestial bodies can only be used for peaceful purposes.
- Any astronaut from any state is an "envoy of mankind," and signatory states must provide all possible help to astronauts when needed, including emergency landing in a foreign country or at sea.
- Signatory states are each responsible for their space activities, including private commercial endeavors, and must provide authorization and continuing supervision.
- States are responsible for damage caused by their space objects and must avoid contaminating space and celestial bodies.

The Rescue Agreement (December 3, 1968) | ***Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*** — Signatories agree to take all possible actions to help or rescue astronauts in need, and if applicable, return them to the state from which they launched. Additionally, signatories agree to help return to the sponsoring state any space objects that land on Earth outside of the country from which they were launched. Ratifying states: 98.

The Liability Convention (September 1, 1972) | ***Convention on International Liability for Damage Caused by Space Objects*** — Signatories take full liability for any damage caused by their space objects and agree to standard procedures for adjudicating damage claims. Ratifying states: 98.

The Registration Convention (September 15, 1976) | ***Convention on Registration of Objects Launched into Outer Space*** — Expanding a space object register, the agreement empowers the UN Secretary-General to maintain a register of all space objects. Ratifying states: 76.

The Moon Agreement (July 11, 1984) | ***Agreement Governing the Activities of States on the Moon and Other Celestial Bodies"*** — States that celestial bodies can only be used for peaceful purposes and that if resource mining on the Moon becomes feasible, an international regime must be established to govern how those resources are obtained and used. Ratifying states: 17.

Mr. Dean Rusk (2nd from right), Secretary of State of the United States, signing the Outer Space Treaty at a White House ceremony on October 10, 1967. At the table, right to left: President Lyndon B. Johnson of the United States; Ambassador Arthur J. Goldberg, Permanent Representative of the United States to the UN; Sir Patrick Dean, Minister of State for Foreign Affairs and Permanent Representative of the United Kingdom to the UN; and USSR Ambassador to the United States Anatoly F. Dobrynin. *UN Photo*

THE ARTEMIS ACCORDS AND MISSIONS

THE ARTEMIS ACCORDS

The Artemis Accords are a set of principles that signatories observe for 21st century space exploration and use. Unlike the 1967 United Nations Outer Space Treaty, the Artemis Accords are non-binding, meaning signatories voluntarily adhere to the principles in their space activity and without enforcement. The Accords present 10 principles to space civil space activity:

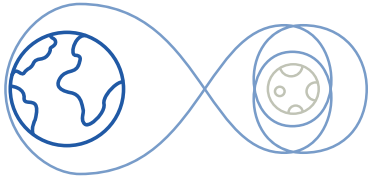
- **Peaceful Purposes** – Cooperative space activities are exclusively for peaceful, lawful purposes.
- **Transparency** – Commitment to the dissemination of information on national space policies and space exploration plans.
- **Interoperability** – Cooperating countries strive for asset interoperability to promote safe and robust space activity.
- **Emergency Assistance** – Signatories agree to take all reasonable efforts to render aid to people in distress in outer space.
- **Registration of Space Objects** – All space objects are registered (in line with the Registration Convention) to avoid harmful interference or collisions in space.
- **Release of Scientific Data** – Scientific data resulting from space activity will be shared with the global community, timely and transparently.
- **Protecting Heritage** – Signatories agree to preserve historically significant human and robotics landing sites and artifacts (e.g., Apollo landing sites).
- **Space Resources** – Signatories will use resources to sustainably benefit humankind.
- **Deconfliction of Activities** – Signatories will provide notification of space activities and coordinate with stakeholders to avoid harmful interference.
- **Orbital Debris and Spacecraft Disposal** – Signatories will limit and remove orbital debris to maintain a safe, sustainable space environment.

Signatories as of January 2025

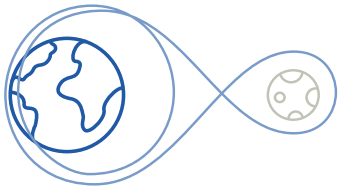
Angola
Argentina
Armenia
Australia
Austria
Bahrain
Belgium
Brazil
Bulgaria
Canada
Chile
Colombia
The Republic of Cyprus
Czech Republic
Denmark
Dominican Republic
Ecuador
Estonia
Finland
France
Germany
Greece
Iceland
India
Israel
Italy
Japan
Liechtenstein
Lithuania
Luxembourg
Mexico
Netherlands
New Zealand
Nigeria
Panama
Peru
Poland
The Republic of Korea
Romania
Rwanda
Saudi Arabia
Singapore
Slovakia
Slovenia
Spain
Sweden
Switzerland
Thailand
Ukraine
The United Arab Emirates
The United Kingdom
The United States
Uruguay

THE ARTEMIS MISSIONS

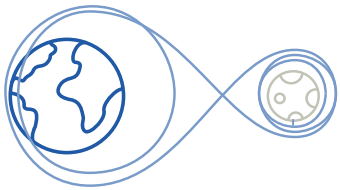
NASA's **Artemis missions** aim to return humans to the Moon, establish a sustainable lunar presence, and prepare for future crewed missions to Mars.



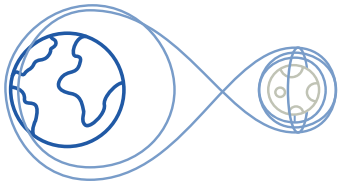
Artemis I was an uncrewed flight test of the Space Launch System and the Orion spacecraft around the Moon launched on Nov. 16, 2022.



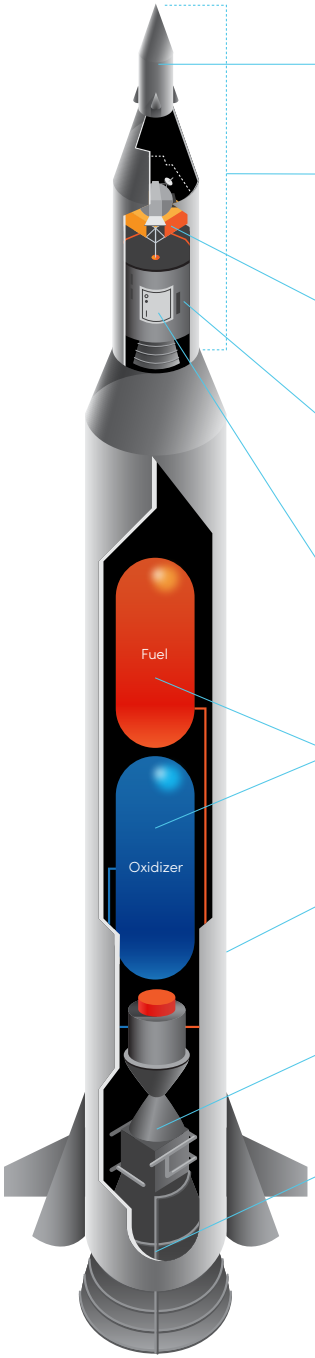
Artemis II will be the first crewed flight test of the Space Launch System and the Orion spacecraft around the Moon.



Artemis III will send the first humans to explore the region near the lunar South Pole, returning humanity to the moon for the first time since 1972.



Artemis IV will debut humanity's first lunar space station (Gateway), a larger, more powerful version of SLS, and a new mobile launcher.



Launch Abort System (LAS): The LAS sits atop the payload, and if launch conditions threaten the crew, it fires a solid-fuel rocket that carries the payload away from the system.

Payload Fairing: The payload experiences extreme pressure and heat as it climbs and is covered with a protective nose cone.

Crew or Cargo Module: The section containing whatever is being delivered to space, be it supplies for a space station, a satellite, or crew and passengers.

Service Module: The payload's propulsion and power systems provide thrust in space and allow the payload to maneuver.

Guidance System: Sensors, computers, radars, and communication equipment coordinated with exhaust nozzles for rocket stability during launch, ascent, and maneuvers.

Liquid Fuel: Most main engines mix a fuel (e.g., liquid hydrogen) and an oxidizer (e.g., liquid oxygen) in a combustion chamber.

Structural System: All of the parts constituting the frame of the launch system.

Rocket Engine: Engines burn fuel in a chamber, which causes the resulting gas to expand at supersonic speed.

Nozzle: Accelerates the flow of gas from the combustion chamber to produce thrust.

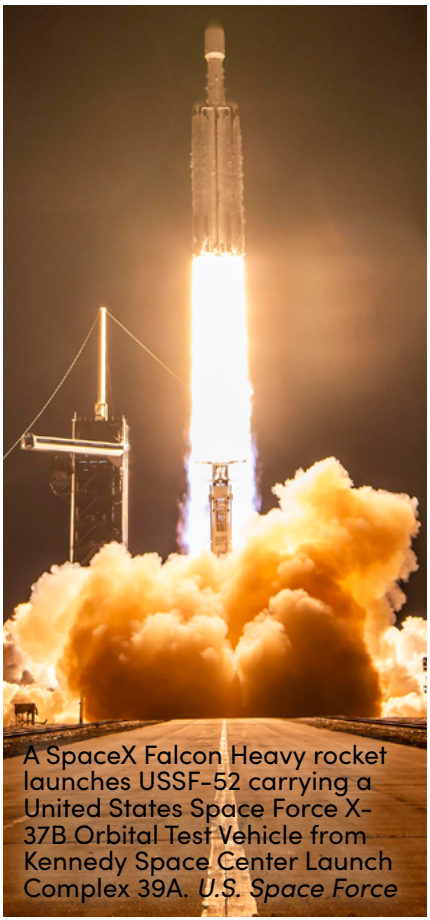
Disclaimer: Every rocket system is unique. This graphic is intended to offer a generic summary of a rocket system and its parts.

COMMERCIAL SPACE LAUNCH PROVIDERS

TYPE	MANUFACTURER
Heavy Lift (20,000+ kg to LEO)	• **Arianespace** • **Blue Origin** • **Northrop Grumman** • **SpaceX** • **United Launch Alliance (ULA)**
Light (less than 2,000 kg) and Medium (2,000-20,000 kg) Lift	• **Agnikul Cosmos** (light) • **Astra** (light) • **Avio** (light and medium) • **Rocket Lab** (light and medium) • **Skyroot Aerospace** (light)
Space Planes/Air-Launch-to-Orbit	• **Sierra Space** • **Virgin Galactic**

SPACE DOMAIN AWARENESS

Space domain awareness (SDA) refers broadly to an understanding of the space environment and all the activity occurring within it. It is a term commonly used in the national security context. Space situational awareness (SSA), which is concerned with tracking and cataloging objects in orbit, is a component of SDA. However, the broader field of SDA is also concerned with deciphering the intent of those objects (e.g., a discarded, uncontrolled rocket stage vs. an actively controlled spacecraft deployed by an adversary).



A SpaceX Falcon Heavy rocket launches USSF-52 carrying a United States Space Force X-37B Orbital Test Vehicle from Kennedy Space Center Launch Complex 39A. *U.S. Space Force*

SDA/SSA PROGRAMS

SPACE SURVEILLANCE NETWORK

Operated by USSF, the SNN is a global network of ground-based sensors and tracking systems that inform an up-to-date catalog of satellites.

COMMERCIAL SPACE SITUATIONAL AWARENESS DATA SHARING AGREEMENTS

Operated by U.S. Space Command, SSA data-sharing agreements promote data exchange with commercial, intergovernmental, and academic organizations engaged in space activities.

ESA SSA PROGRAMME

Develops capabilities to track objects in orbit that could disrupt other satellites or impact ground-based infrastructure.

SPACE DATA ASSOCIATION

An international organization of satellite operators working, in part, to enhance the "accuracy and timeliness of collision warning notifications."

ORBITAL DEBRIS AND SPACE SUSTAINABILITY

Orbits are becoming more congested for three primary reasons. First, there is more space activity today than ever before, with fast-improving launch capabilities and a proliferation of spacecraft. Second, as of 2024, there are about 10,000 satellites in orbit, with numbers growing as satellite mega-constellations come online. Third is the fragmentation of legacy space debris from 60 years of space activity. The solutions are twofold:

DEBRIS MITIGATION

National and international standards set requirements for preventing the creation of new debris in space launch and operation. Standards, such as those from the International Organization of Standardization, require spacecraft and launch systems to be designed in a way that prevents debris generation.

DEBRIS REMEDIATION

Research and testing is progressing on technologies needed to capture and deorbit discarded, uncontrolled debris. ESA, JAXA, and the UK Space Agency are funding missions to develop and prove out space systems for debris remediation.

ANTI-SATELLITE WEAPONS (ASAT)

An ASAT is a weapon that performs a kinetic attack on a space-based asset. ASAT tests are considered harmful to space sustainability as the destruction of a satellite can create thousands of trackable pieces of debris. To date, four countries have conducted ASAT tests: China, India, Russia, and the United States.

COMMONLY USED ACRONYMS

- AFSPC — Air Force Space Command
- AST — Office of Commercial Space Transportation
- CST — Commercial Space Transportation
- DARPA — U.S. Defense Advanced Research Projects Agency
- DIA — Defense Intelligence Agency
- DOD — Department of Defense
- DOT — Department of Transportation
- FAA — Federal Aviation Administration
- FCC — Federal Communications Commission
- HAC-CJS — House Appropriations Committee: Commerce, Justice, Science, and Related Agencies
- HAC-D — House Appropriations Committee: Defense
- HASC — House Armed Services Committee
- HSST — House Committee on Science, Space and Technology
- JPL — Jet Propulsion Laboratory
- NASA — National Aeronautics and Space Administration
- NGA — National Geospatial-Intelligence Agency
- NOAA — National Oceanic and Atmospheric Administration
- NRO — National Reconnaissance Office
- NSF — National Science Foundation
- OSC — Office of Space Commerce
- SAC-CJS — United States Senate Committee on Appropriations: Commerce, Justice, Science, and Related Agencies
- SAC-D — United States Senate Committee on Appropriations: Defense
- SASC — Senate Armed Services Committee
- USSF — U.S. Space Force
- USSPACECOM — U.S. Space Command
- USSTRATCOM — U.S. Strategic Command

SOURCE MATERIALS

The information contained herein comes from publicly available resources (e.g., official government records/websites, reported statistics, etc.) as well as research and analysis work completed by Space Foundation. Given the dynamic changes always happening within the global space community, there will be changes and new developments that evolve official reporting numbers, statistics, participants, policies, etc. Readers are always encouraged to search for the latest information from official records/websites and databases, as well as consult The Space Report (www.thespacereport.org), which is produced by Space Foundation.

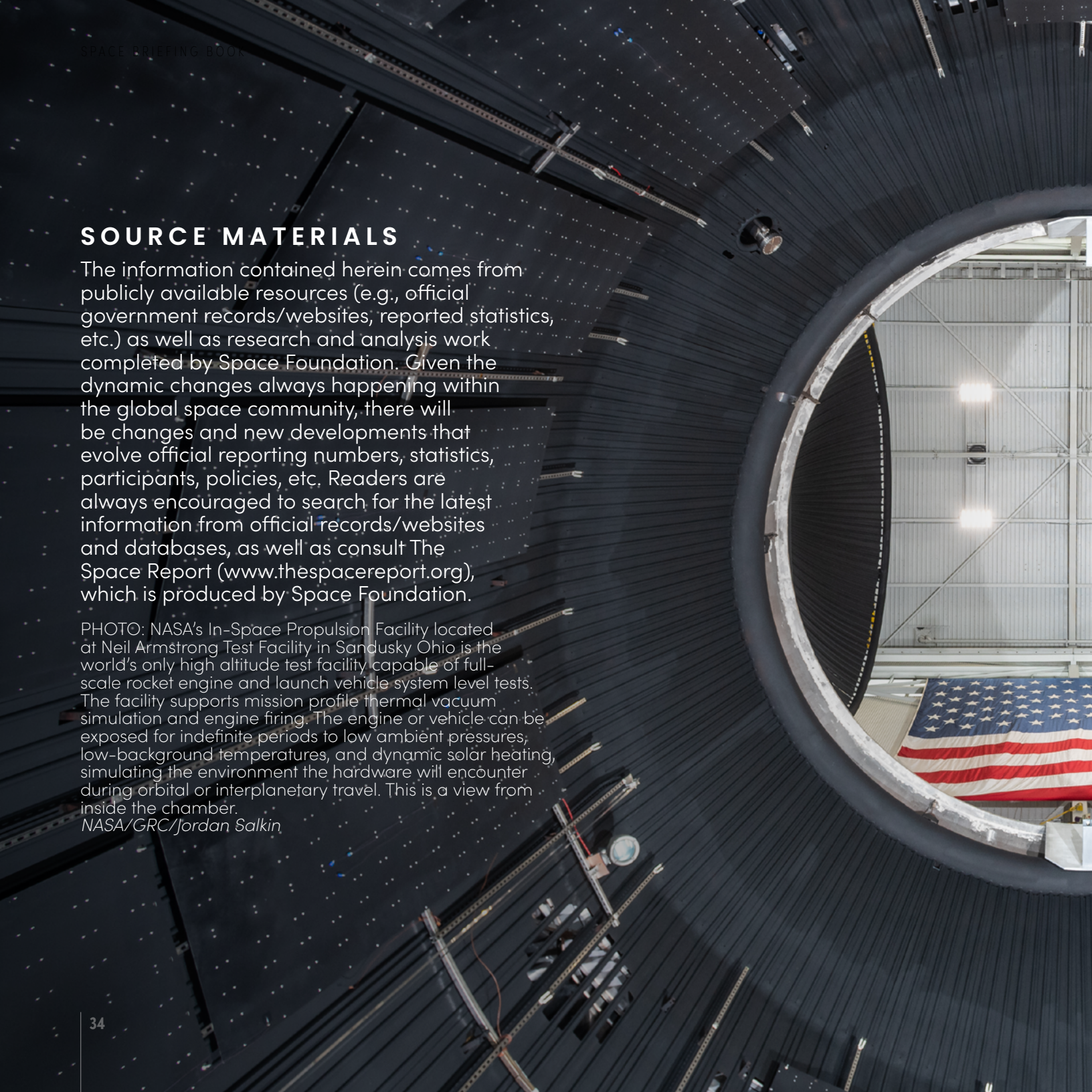


PHOTO: NASA's In-Space Propulsion Facility located at Neil Armstrong Test Facility in Sandusky Ohio is the world's only high altitude test facility capable of full-scale rocket engine and launch vehicle system level tests. The facility supports mission profile thermal vacuum simulation and engine firing. The engine or vehicle can be exposed for indefinite periods to low ambient pressures, low-background temperatures, and dynamic solar heating, simulating the environment the hardware will encounter during orbital or interplanetary travel. This is a view from inside the chamber.
NASA/GRC/Jordan Salkin

ABOUT SPACE FOUNDATION

Space Foundation is a non-profit organization founded in 1983 as a gateway to unite the global space community. Space Foundation uniquely educates, collaborates, and informs the entire space workforce from early education to college, to the start of their careers as new professionals, to leaders at the highest levels in government and commercial industry. Driven by partnerships, Space Foundation raises support from corporate members, sponsors, individual giving, and grants.

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