SPACE SYSTEMS

SPACE DOMAIN AWARENESS

U.S. Space Force courtesy photo

Space Delta 2 operates the 20th Space Control Squadron's AN/FPS-85 phased array radar, located at Eglin Air Force Base, Fla. The giant radar has made thousands of space observations daily, all contributing to the space domain awareness mission.

By Aidan Poling

AN/FPS-85 (EGLIN PHASED ARRAY RADAR)

Space Domain Awareness

Brief: The AN/FPS-85 is a very large-fixed array radar located at Eglin AFB. Initially designed to track satellites, a software update installed in 1975 enabled the unit to track submarine-launched ballistic missiles, or SLBMs. This became the 20th Space Surveillance Squadron's primary mission, while space surveillance became secondary. From 1971 to 1984 the 20th Surveillance Squadron served as the Alternate Space Surveillance Center, providing computational support to the Space Surveillance Center at Cheyenne Mountain AS, Colo. If the need arose, the squadron could assume command and control of worldwide SSN. During the 1980s, the AN/FPS-85 was the proving ground for development of phased array radars designed specifically for early warning of SLBM attacks. The AN/FPS-85 can detect, track, and identify up to 200 satellites simultaneously and provides 120-degree azimuth of coverage. Generating a combined output of 32 megawatts, the radar can track an object the size of a basketball at a range of more than 35,000 km.

Contractors: AlliedSignal Inc. (prime contractor for the radar); Bendix Communications Division; IBM Computers; L3Harris (sustainment).
Operator/Location: 20th Space Surveillance Squadron, Eglin AFB, Fla.
IOC: 1968.
Active Systems: One radar.

AN/FSY-3 (SPACE FENCE)

Space Domain Awareness

Brief: The AN/FSY-3 (Space Fence) S-band radar is the dedicated southern hemisphere space surveillance asset, capable of low-inclination tracking. Operated by the 20th Space Surveillance Squadron, it can detect, track and identify up to 500 satellites simultaneously. The unique structural design allows for 360-degrees of azimuth coverage. The antenna covers +20° to +90° elevation. The radar can track an object the size of a beach ball at a range of more than 36,000 km.

Contractor: Lockheed Martin.
Operator/Location: 20th Space Surveillance Squadron, Kwajalein Atoll, Marshall Islands.
IOC: 2020.
Active Systems: One S-band radar.

GEODSS (GROUND-BASED ELECTRO-OPTICAL DEEP SPACE SURVEILLANCE) SITES

Space Domain Awareness

Brief: Since the early 1980s, the Ground-Based Electro-Optical Deep Space Surveillance (GEODSS) System has played a central role in tracking deep space objects. It is a nine passive sensor array of visible wavelength reflecting telescopes. These are globally distributed across the following three sites (with three telescopes per site):

- **White Sands Missile Test Range, Socorro, N.M.**
  Operated by Det. 1, 15th Space Surveillance Squadron
- **Diego Garcia, British Indian Ocean Territories**
  Operated by Det. 2, 15th Space Surveillance Squadron
- **Mount Haleakala, Maui Island, Hawaii**
  Operated by Det. 3, 15th Space Surveillance Squadron.

These telescopes play a central role in tracking deep space objects and are each able to "see" objects 10,000 times dimmer than the human eye. Over the years, the GEODSS systems have undergone several refurbishments and upgrades, the most significant being the addition of digital cameras. These highly sensitive digital camera technologies—developed under a program known as Deep STARE—can detect multiple satellites in the telescope's field of view. The telescopes take rapid electronic snapshots of satellites in the night sky, showing up on the operator's console as tiny streaks. Star images, which remain fixed, are used as reference or calibration points for each of the three telescopes. The resulting observation data is then sent instantaneously to Delta 2 for the management of the satellite catalog data.

Contractors: MIT Lincoln Labs (initial RDTE); TRW (prime contractor for design and development radar, acquired by Northrop Grumman); Sarnoff Corp. (Deep STARE upgrade).
Operator/Location: 15th Space Surveillance Squadron, Diego Garcio; White Sands Missile Range, N.M.; Maui.
IOC: 1982.
Active Systems: Nine passive sensor array telescopes.

MAUI SPACE SURVEILLANCE SYSTEM (MSSS)

Space Domain Awareness

Brief: The Maui Space Surveillance Complex (MSSC) is national space surveillance and research asset. Located at the 10,023-foot summit of Haleakala on the island of Maui, Hawaii, the MSSC hosts small-, medium-, and large-aperture tracking optics, including the DOD's largest optical telescope designed for tracking and imaging satellites, with visible and infrared sensors to collect data on near-Earth and deep-space objects. The MSSS is operated by the 15th Space Surveillance Squadron. The AEOS 3.6 m and other smaller contributing telescope systems validate and develop advanced technology for transition to the dedicated sensor baseline while also executing a contributing SDA mission on behalf of the USSF. These contributing sensors support experiments and leverage R&D capabilities by like AFRL. DOD began conducting research and development and operational missions on Mount Haleakala in the early 1960s at the Advanced Research Projects Agency Midcourse Observation Station, which is known today as the Maui Space Surveillance Complex. Originally built as an electro-optical observation platform for missile tests, the site has evolved into a world-class observatory supporting missions in space control, laser propagation, and other related fields.

Contractors: University of Michigan (initial telescope RDT&E); Lockheed Martin (O&M); Rockwell (O&M); Raytheon (optical upgrade).
Operator/Location: 15th Space Surveillance Squadron, Air Force Maui Optical and Supercomputing Site, Hawaii.
IOC: 1977 (SAC takes operational control).

SILENT BARKER

Space Domain Awareness

Brief: Silent Barker is a classified space-based Space Situational Awareness (SSA) system jointly developed by the U.S. Space Force (USSF) and the National Reconnaissance Office (NRO). It was launched in September 2023. The system consists of three satellites designated USA 346, USA 347, and USA 348, which were placed into orbit above geosynchronous Earth orbit (GEO) at a 12-degree inclination. After approximately a year of on-orbit testing, the first series of Silent Barker satellites became operational in early 2025. The system is expected to reach full operational capacity following a planned launch in FY2026. Silent Barkers mission differs from the Geosynchronous Space Situational Awareness Program (GSSAP). Silent Barker is focused on wide area surveillance while GSSAP is responsible for doing characterization to detect anomalies or provide intricate characterization of satellites in geosynchronous orbit. Data collected by Silent Barker is transmitted to classified military users including the USSF's National Space Defense Center and the Combined Space Operations Center, while the NRO operates the satellites.

Contractors: Not specified in the available information.
Operator/Location: USSF and NRO.
First Launch: Sept. 10, 2023.
IOC: Early 2025.
Launch Vehicle: Atlas V.
Constellation: Three satellites in first series, with more planned.
Active Satellites:
- USA 346. Launched in September 2023; active.
- USA 347, Launched in September 2023; active.
- USA 348. Launched in September 2023; active.

Orbit Altitude: Above geosynchronous Earth orbit (GEO) at 12-degree inclination
- GSSAP 5. Launched in 2022, on orbit, active.
- GSSAP 6. Launched in 2022, on orbit, active.

Orbit Altitude: Near-geosynchronous at 22,300 miles.

SPACE-BASED SPACE SURVEILLANCE (SBSS)

Orbital Surveillance and Object Identification

Brief: SBSS is designed to track, characterize, measure, and collect optical signatures of Earth-orbiting objects, including space vehicles and debris. SBSS primarily uses a trainable, ground-controlled Space-Based Visible Sensor to track satellites to cover a four-year gap in coverage until the newly established Space Force can launch a follow-on spacecraft. SBSS works in concert with an array of networked, ground-based sensors including the Space Fence wide-area search and surveillance system recently commissioned on Kwajalein Atoll in the Marshall Islands. SBSS collision-warning data were made openly available to the public in 2020 to improve domain awareness and orbital safety, and USSF is considering handing off operations to a contracted service provider.

Contractors: Boeing (system integration, ground segment, operations and sustainment); Ball Aerospace (satellite).
Operator/Location: USSF SpOC, Space Delta 9 (DEL 9), 1st Space Operations Squadron (1 SOPS), Schriever SFB, Colo.
First Launch: Sept. 25, 2010.
IOC: Aug. 17, 2012 (SBSS).
Design Life: Seven yr.
Launch Vehicle: Minotaur IV.
Constellation: One LEO satellite; one LEO augmentation satellite.
Active Satellites:
- SBSS Block 10. Launched in 2010; active.

UPGRADED EARLY WARNING RADAR (UEWR)

Missile Warning/Tracking

Brief: The Upgraded Early Warning Radar (UEWR) system provides advanced ballistic missile detection, tracking, and space surveillance capabilities for the United States Space Force. The UEWR network consists of powerful phased-array radar systems strategically positioned in the United States and abroad. These radars are capable of detecting and tracking intercontinental ballistic missiles (ICBMs), sea-launched ballistic missiles (SLBMs), and conducting space domain awareness operations, including satellite tracking. The system operates 24/7 to provide critical early warning of potential missile threats and contribute to space surveillance networks. UEWR represents a significant modernization and upgrade of the previous generation Ballistic Missile Early Warning System (BMEWS) and PAVE PAWS radars with enhanced detection capabilities and improved integration with missile defense systems. The radar systems utilize advanced phased-array technology that allows for rapid electronic beam steering without the need for mechanical movement of the antenna. This enables simultaneous tracking of multiple targets while maintaining broad surveillance coverage across a 240- to 360-degree field of view. Operating in the Ultra High Band Frequency, these radars boast wide area coverage but are not able to perform midcourse discrimination. The modernized systems feature upgrades to approximately 80 percent of radar and computer subsystems, along with completely rewritten software to enhance midcourse ballistic missile defense system coverage through improved early warning, tracking, object classification, and cueing data.

Contractors: Raytheon (prime); SAIC (sustainment).
Operator/Location:
- 6th Space Warning Squadron, Space Delta 4, SpOC, Cape Cod AFS, Mass.
- 7th Space Warning Squadron, Space Delta 4, SpOC, Beale AFB, Calif.
- 12th Space Warning Squadron, Space Delta 4, SpOC Pituffik SFB, Thule, Greenland.
- 13th Space Warning Squadron, Space Delta 4, SpOC, Clear AFS, Alaska.
- RAF Fylingdales (operated by RAF with USSF liaison), U.K.

IOC: 2005, Beale AFB location.
Active Systems: five radar, globally distributed.

Northrop Grumman

ADVANCED EXTREMELY HIGH FREQUENCY (AEHF) SATELLITE SYSTEM

Communications

Brief: AEHF provides global, secure, protected, and jam-resistant military

communications. It enhances the previous Milstar satellites and operates at a much higher capacity and data rate. It offers secure, anti-jam tactical and strategic communications around the world. AEHF uses cross-linked satellites, eliminating the need for ground relay stations. The program is a collaboration with Australia, Canada, the Netherlands, and the United Kingdom. SV-4 launched on Oct. 17, 2018; full operational capability was declared when the vehicle joined the constellation on May 3, 2019. SV-5 launched Aug. 8, 2019, and SV-6 launched from Cape Canaveral on March 26, 2020, marking the newly formed USSF's first launch. SV-6 became operational after completing on-orbit checks on Aug. 22, 2020, completing the constellation. USSF plans to begin replacing AEHF with the next-generation Evolved Strategic SATCOM (ESS) for nuclear C2 starting in the early 2030s, while developing Protected Tactical SATCOM (PTS) to relive AEHF of providing contested battlefield comms. Both Boeing and Northrop Grumman received ESS prototype contracts ahead of a competitive selection expected this year. USSF is developing the Protected Tactical Enterprise Service (PTES) to enable global anti-jam, low probability of intercept comms. PTES waveforms will initially be fielded on WGS, later expanding commercial satellites and eventually to PTS. USSF plans to complete prototype PTS payloads in FY25 for hosted launch on WGS-11 as well as a second stand-alone satellite.

Contractors: Lockheed Martin; Northrop Grumman.
Operator/Location: USSF SpOC, Space Delta 8 (DEL 8), 4th Space Operations Squadron (4 SOPS), Schriever SFB, Colo.
First Launch: Aug. 14, 2010.
IOC: 2015.
Design Life: 14 yrs.
Launch Vehicle: Atlas V.
Constellation: Six.
Active Satellites:
▪AEHF SV-1. Launched in 2010, on orbit and operational.
▪AEHF SV-2. Launched in 2012, on orbit and operational.
▪AEHF SV-3. Launched in 2013, on orbit and operational.
▪AEHF SV-4. Launched in 2018, on orbit and operational.
▪AEHF SV-5. Launched in 2019, on orbit and operational.
▪AEHF SV-6. Launched in 2020, on orbit and operational.
Dimensions: Length 31 ft, width 98 ft (with full solar array extension).
Weight: 14,500 lbs at launch, 9,000 lbs on-orbit.
Performance: 24-hr low, medium, and extended data rate connectivity from 75 bps to approx. 8 Mbps, from 65 north to 65 south latitude worldwide.
Orbit Altitude: Geosynchronous at 22,500 miles.
Power: Solar arrays generating 20,000 watts.

CONTINUOUS BROADCAST AUGMENTING SATCOM

Satellite Communications

Brief: The Continuous Broadcast Augmenting SATCOM is a set of geostationary satellites designed to provide communications relay capabilities to support senior leaders and combatant commanders. The CBAS system includes two satellites in geostationary orbit designed to broadcast military data continuously through space-based satellite communications relay links. The satellites enhance existing military satellite communications capabilities by providing additional relay capacity for time-sensitive information. The system supports the communication needs of senior leadership and combat commanders with secure, reliable data transmission. The first CBAS satellite (CBAS-1) was successfully launched on April 14, 2018, from Cape Canaveral as the primary payload on the AFSPC-11 mission aboard an Atlas V rocket directly into geostationary orbit. CBAS-2 was subsequently launched on Jan. 15, 2023, on a Falcon Heavy rocket as part of the USSF-67 mission. A third satellite (CBAS-3) is planned for future deployment to further enhance the constellation's capabilities. The system transitioned from U.S. Air Force to U.S. Space Force operations following the creation of the Space Force in December 2019. CBAS is managed by Space Systems Command, formerly the Military Satellite Communication Director of USAF's Space and Missile Defense Center.

Contractor: Boeing
Operator/Location: USSF SpOC; Schriever SFB, Colo.
Acquisition Organization: Military Satellite Communication Director of USAF's Space and Missile Defense Center (now Space Systems Command.)
First Launch: CBAS 1, March 14, 2018.
IOC: 2018
Launch Vehicle: Atlas V (GEO). Falcon Heavy.
Constellation: Two GEO satellites.
Active Satellites:
▪CBAS 1. Launched in 2018; active.
▪CBAS 2. Launched in 2023; active.
Dimensions: Not publicly available.
Weight: 4,400-6,600 lb. (GEO on orbit).
Orbit Altitude: Geostationary.
Power: Deployable solar array, (GEO). Batteries.

DEFENSE SATELLITE COMMUNICATIONS SYSTEM III (DSCS III)

Satellite Communications

Brief: The Defense Satellite Communications System III (DSCS III) is the third generation of the U.S. military's premier geostationary communications constellation, succeeding the earlier DSCS II satellites. Beginning in 2007, it began to be phased out in favor of the Wideband Global SATCOM (WGS) Originally comprised of 14 satellites launched between October 1982 and August 2003, the constellation now consists of four satellites. These final four satellites received Service Life Enhancement Program (SLEP) modifications that provide substantial capacity improvements through higher-power amplifiers, more sensitive receivers, and additional antenna connectivity options. The DSCS communications payload includes six independent Super High Frequency (SHF) transponder channels that cover a 500 MHz bandwidth. The DSCS III satellites carry six independent Super High Frequency (SHF) transponders and one special purpose single channel transponder operating on both SHF and Ultra High Frequency (UHF). The satellites feature three receive antennas (two Earth coverage horns, one steerable 61-beam nulling lens) and five transmit antennas (two Earth coverage horns, two steerable 19-beam wave guide lenses, one high gain parabolic gimbaled dish). Two solar wings produce 1700 Watts of onboard power at the beginning of life and 1230 watts at the end of life.

Contractor: Lockheed Martin
Operator/Location: 53rd Space Operations Squadron, USSF, Schriever SFB, Colo.
Acquiring Agency: MILSATCOM Systems Directorate, Space and Missile Systems Center (SMC), now Space Systems Command.
First Launch: DSCS-3 A1, Oct. 30, 1982.
IOC: GEO 1, Dec. 5, 2008. (Increment 1, Dec. 8, 2001)
Launch Vehicle: Titan-34, Delta-4, Space Shuttle, Atlas-2.
Constellation: Four GEOs.
Active Satellites:
▪ DSCS-3 B13 (#10) (USA 134); Launched October 25, 1997; Active.
▪ DSCS-3 B8 (#11) (USA 148); Launched January 21, 2000; Active.
▪ DSCS-3 A3 (#13) (USA 167); Launched March 11, 2003; Active.
▪ DSCS-3 B6 (#14) (USA 170); Launched August 29, 2003; Active.
Dimensions: Not available
Weight: 2,722 lb.
Orbit Altitude: Geostationary.
Power: 2 deployable solar arrays, 1700 watts, batteries

FLTSATCOM (BLOCK 2)

Satellite Communications

Brief: Fleet Satellite Communications System (FLTSATCOM) currently consists of two operational satellites used by the Air Force, Navy, and presidential command network. The system is designed to provide secure communications links among the three users. Each FLTSATCOM satellite includes 22 communications channels in the ultra-high and super-high frequency bands that support nuclear command and control. FLTSATCOM Block 2 (consisting of FLTSATCOM 6-8) is an upgrade from the FLTSATCOM Block 1 design and includes an Extremely High Frequency (EHF) communications package that served as a test bed for Milstar system terminals. Today only FLTSATCOM 7 and 8 remain operational today. Both were transferred to the USSF in 2021 following the stand up of the Space Force.

Contractor: TRW (prime contractor), acquired by Northrop Grumman.
Acquiring Agency: Space and Naval Warfare Systems Command.
Operator/Location: 10th Operations Squadron, USSF. Point Mugu, Calif.
First Launch: FLTSATCOM 7, May 1986.
IOC: FLSATCOM 7, May 1986.
Launch Vehicle: Atlas Centaur (GEO)
Constellation: Two GEO sats.
Active Satellites:
▪FLSATCOM 7. Launched in 1987; active.
▪FLSATCOM 8. Launched in 1989; active.
Dimensions: 8.2 ft diameter, 4.3 ft height.
Weight: 5,094 lb.

Performance: Geostationary orbit.
Orbit Altitude: Geostationary.
Power: Solar array, 1,400 watts (GEO), batteries.

MILSTAR SATELLITE COMMUNICATIONS SYSTEM (MILSTAR)

Communications

Brief: Milstar is the legacy joint-service backbone of strategic/tactical DOD communications. It provides encrypted, secure, anti-jam communications around the world and uses cross-linked satellites, eliminating the need for ground relay stations. Block I satellites incorporate a low-data-rate payload capable of transmitting 75 to 2,400 bps over 192 EHF channels. Block II satellites carry both the low-data-rate payload and a medium-data-rate payload capable of transmitting 4,800 bps to 1.5 Mbps over 32 channels, allowing larger data to be passed more quickly. Interoperable terminals allow third-party land/sea-based units to upload data in real time to cruise missiles or other compatible weapons. Milstar provides continuous coverage between 65 degrees north and 65 degrees south latitude. The systems utilize multiple-redundant command and control for high survivability. The last of six satellites launched in 2003 and was augmented by the sixth and final AEHF satellite in 2020. AEHF now supplants Milstar as DOD's primary system in the combined, fully back-compatible AEHF-Milstar constellation. Milstar surpassed 30 years of operations Feb. 7, 2024, exceeding its on-orbit design life by three times.

Contractors: Lockheed Martin; Boeing; Northrop Grumman (formerly TRW).
Operator/Location: USSF SpOC, Space Delta 8 (DEL 8); 4th Space Operations Squadron (4 SOPS), Schriever SFB, Colo.
First Launch: Feb. 7, 1994.
IOC: July 1997 (Milstar I).
Design Life: 10 yr.
Launch Vehicle: Titan IV/Centaur.
Constellation: 5: two Milstar I; three Milstar II.
Active Satellites:
▪Block I. Milstar I satellites launched 1994-95.
▪Block II. Milstar II satellites launched 1999-2003.
Dimensions: Length 51 ft, width 116 ft with full solar array extension.
Weight: 10,000 lb.
Performance: Milstar I low-data-rate (LDR) payload transmitting 75 to 2,500 bps of data over 192 channels of EHF; Milstar II LDR and medium-data-rate (MDR) payloads, transmitting 4,800 bps to 1.5 Mbps over 32 channels.
Orbit Altitude: Geosynchronous at 22,000+ miles.
Power: Solar arrays generating 8,000 watts.

MOBILE USER OBJECTIVE SYSTEM (MUOS)

Communications

Brief: MUOS provides next-generation global UHF narrowband and BLOS military SATCOMS. The constellation was originally developed by Lockheed Martin for the Navy and is designed to replace the legacy UHF Follow-On (UFO) system, enabling a tenfold increase in capacity as well as interoperability with legacy terminals. Each satellite is equipped with an advanced SATCOM payload that converts 3G cellular-like service to military UHF as well as a UHF payload compatible with UFO terminals. MUOS provides tactical air, land, and sea platforms reliable SATCOMS even in challenging terrain and weather conditions and also extends SATCOMS to the high Arctic. The system utilizes both geosynchronous satellites and ground-station relays to provide mobile phone-type, voice, text, and data to users in the field. MUOS can interface with the Defense Switched Network and DOD's Global Information Grid offering clear voice and videoconferencing over existing networks. The system comprises four operational satellites, an on-orbit spare, and four ground relay stations in addition to networking and satellite control. USSF aims to procure two additional MUOS satellites targeted for launch by 2030, coinciding with the projected end life of the initial vehicles. Service life extension efforts initiated by the Navy would procure two additional satellites, equipped only with the advanced Wideband Code Division Multiple Access (WCDMA) payload to replace the oldest satellites in orbit by 2030. Full exploitation of MUOS' capabilities has been hampered by the slow modernization of user platforms to date, and many USAF platforms are in the process of transition. The Naval Satellite Operations Center transferred its remaining UHF satellites, including five legacy UHF Follow-Ons, a single remaining UHF FLTSAT, and two range-extending nanosats to the USSF along with control of MUOS on June 6, 2022. FY25 funds focus on modernizing software and correcting cyber vulnerabilities to the six Ground Segment sites. Canada reached IOC becoming the first allied MUOS user in June 2024, with full operational capability for Canadian Forces planned in 2026.

Contractor: Lockheed Martin.
Operator/Location: USSF SpOC, Space Delta 8 (DEL 8), 10th Space Operations Squadron (10 SOPS), Naval Base Ventura County, Calif.; Schriever SFB, Colo.
First Launch: Feb. 24, 2012.
IOC: 2012.
Design Life: 14 yrs.
Launch Vehicle: Atlas V.
Constellation: Four (plus one on-orbit spare).
Active Satellites:
▪MUOS-1. Launched in 2012, on orbit and operational (CONUS/Americas).
▪MUOS-2. Launched in 2013, on orbit and operational (Pacific).
▪MUOS-3. Launched in 2015, on orbit and operational (Atlantic).
▪MUOS-4. Launched in 2015, on orbit and operational (Indo-Asia).
▪MUOS-5. Launched in 2016, on-orbit spare.
Dimensions: Length 21.9 ft, height 12 ft, width 6 ft (with full solar array stowed), 90 ft (with solar arrays deployed); two deployable reflector arrays 17.7 ft (legacy UHF), and 45.9 ft (MUOS).
Weight: 8,405 lb (including 6,450 lb of fuel).
Performance: UHF narrowband/BLOS 3G-equivalent voice, chat, and data 89.5 north to 65 south latitude worldwide.
Orbit Altitude: Geosynchronous.
Power: Two deployable solar arrays.

ULTRA-HIGH FREQUENCY FOLLOW-ON (UFO)

Satellite Communications

Brief: The UHF Follow On (UFO) satellite series provides critical ultra-high frequency communications for the U.S. Navy's global network, serving ships at sea and various military terminals. These satellites replaced the Fleet Satellite Communications (FLTSATCOM) and Hughes-built Leasat spacecraft, establishing a more capable and flexible communications infrastructure. While a total of 11 were launched, beginning in 1993, only four remain operational today. The UFO satellites utilize a modular payload architecture operating in geosynchronous orbit. Earlier satellites (UFO-4 through UFO-7) were built by Hughes and incorporated an EHF payload alongside UHF and SHF capabilities, providing protected communications with anti-jam features. Block 3 satellites (UHF-8 to -10) replaced the SHF payload with the Global Broadcast Service (GBS) package and included four 130-watt, 24 Mbps military Ka-band (30/20 GHz) transponders with three steerable downlink spot beam antennas and dedicated uplink antennas. This technical configuration delivered a 96 Mbps data transmission capability per satellite—a significant increase over previous generations. Block 4 of the UFO was designed by Boeing and consists of a single satellite (UFO-11) launched on Dec. 18, 2003. It was intended to serve as a gap filler between the UFO and MUOS constellations. UFO-11 satellite incorporates the enhanced 20-channel EHF package first introduced on UFO-7, while adding an upgraded UHF payload with a new digital receiver that provides two additional UHF channels and greater flexibility in configuring communication services. UFO-11 maintains the same physical dimensions as earlier non-GBS Block 2 satellites.

Contractors: Hughes (Block 1-3); Boeing (Block 4).
Operator/Location: 10th Operations Squadron, USSF. Point Mugu, Calif.
Acquisition Organization: Space and Naval Warfare Systems Command's Communications Satellite Program Office, USN.
First Launch: UFO-1, March 1993.
IOC: UFO-2, Sep. 3, 1993.
Launch Vehicle: Atlas 3-B, Atlas-2A, Atlas-2, Atlas-1.
Constellation: Four GEO sats.
Active Satellites:
▪UFO 8 (Block 3). Launched in 1998; active.
▪UFO 9 (Block 3). Launched in 1998; active.
▪UFO 10 (Block 3). Launched in 1998; active.
▪UFO 11 (Block 4). Launched in 2003; active.
Dimensions: 75 ft x 11 ft x 11 ft (Block 3), 60 ft x 11 ft x 11 ft (Block 4).
Weight: 7,068 lb. (Block 3), 6,704 lb. (Block 4).
Orbit Altitude: Geostationary.
Power: Solar arrays: 3,800 watts (Block 3), 2,800 watts (Block 4), batteries.

WIDEBAND GLOBAL SATCOM (WGS) SATELLITE

Communications

Brief: WGS provides worldwide, high-capacity communications for deployed air, land, and sea forces. The system is designed to augment and then replace DSCS X-band frequency service. It also augments the one-way Global Broadcast Service Joint Program Ka-band frequency capabilities and provides a new high-capacity, two-way Ka-band frequency service. Block I includes: SV-1 (Pacific region), SV-2 (Middle East), and SV-3 (Europe and Africa). Block II satellites are modified to

better support the airborne ISR mission and include: SV-4 (Indian Ocean), and SV-5 and SV-6, purchased by Australia in 2013. The U.S. is partnering with Canada, Denmark, Luxembourg, the Netherlands, and New Zealand on Block II follow-on satellites SV-7 to SV-10. The Space and Missile Systems Center conducted tests to field anti-jamming capability for SV-1 through SV-10 starting in 2022. Congress added funds to procure the 11th and 12th satellites, but USSF opted for the single, modernized WGS-11+ platform. Congress added FY23 funds to again procure WGS-12 to ensure depth of coverage, augmenting the future Protected Tactical SATCOM (PTS), which will provide battlefield coverage in contested spectrum environments. USSF demonstrated PTS and is working to field an IOC capability using a WGS satellite for the Indo-Asia Pacific theater. The capability could be extended to the full constellation, permitting an advanced anti-jam/low probability of interception bridge to PTS, augmenting the future constellation. The Boeing-designed WGS-11+ will offer roughly twice the capability, in addition to stronger, more reliable coverage and is tentatively slated for launch in 2025. It will host a dedicated PTS payload in addition to being the first WGS satellite carried into orbit by a ULA Vulcan Centaur. Poland and Japan signed agreements to join WGS in 2024 primarily utilizing the two latest satellites.

Boeing

Contractor: Boeing.
Operator/Location: USSF SpOC, Space Delta 8 (DEL 8), 4th Space Operations Squadron (4 SOPS), Schriever SFB, Colo.
First Launch: October 2007.
IOC: April 16, 2008.
Design Life: 14 yr.
Launch Vehicle: Atlas V, Delta IV; planned: Vulcan Centaur (WGS-11).
Constellation: 10 satellites.
Active Satellites:
- SV-1. Block I, launched in 2007; active.
- SV-2. Block I, launched in 2009; active.
- SV-3. Block I, launched in 2009; active.
- SV-4. Block II, launched in 2009; active.
- SV-5. Block II, launched in 2013; active.
- SV-6. Block II, launched in 2013; active.
- SV-7. Block II follow-on, launched in 2015; active.
- SV-8. Block II follow-on, launched in 2016; active.
- SV-9. Block II follow-on, launched in 2017; active.
- SV-10. Block II follow-on, launched in 2019; active.

Dimensions: Based on Boeing 702 Bus.
Weight: 13,000 lb at launch.
Performance: Approx. 10 times the capability of a DSCS satellite.
Orbit Altitude: Geosynchronous.
Power: Solar arrays generating 9,934 watts.

USAF

GEOSYNCHRONOUS SPACE SITUATIONAL AWARENESS PROGRAM (GSSAP)

Situational Awareness/Orbital Tracking

Brief: GSSAP supplies space-based tracking and characterization of man-made objects in geosynchronous orbit, aiding safety, and enabling avoidance. They are the "neighborhood watch" satellites. The satellites operate in near-geosynchronous orbit to effectively monitor objects and aid in preventing collisions in space. GSSAP carry EO/IR sensors and are able to maneuver to observe objects at close range or conduct rendezvous. They can track objects beyond the weather and atmospheric disruptions that affect ground-based systems. Two GSSAP satellites were launched in 2014 and attained IOC in 2015. Two more replenishment satellites launched Aug. 19, 2016, and became operational Sept. 12, 2017. USSF completed a significant overhaul and upgrade of the GSSAP ground system software to enhance the reliability, speed, and security of the system in February 2020. The upgrades also pave the way for future expansion of the constellation. The fifth and sixth sensors launched aboard the USSF-8 mission from Cape Canaveral on Jan. 21, 2022, and were declared operational several months later. USSF announced the on-orbit decommissioning of GSSAP 2 on Aug. 2, 2023. The space service planned to launch two additional GSSAP satellites into orbit in 2024 and 2027 but did not disclose if the 2024 launch went ahead as planned.

Contractor: Northrop Grumman Space Systems.
Operator/Location: USSF SpOC, Space Delta 9 (DEL 9), 1st Space Operations Squadron (1 SOPS), Schriever SFB, Colo.
First Launch: July 28, 2014.
IOC: Sept. 29, 2015.
Launch Vehicle: Delta IV, Atlas V (USSF-8).
Constellation: Six spacecraft.
Active Satellites:
- GSSAP 1. Launched in 2014; on orbit, active.
- GSSAP 2. Launched in 2014, nonoperational orbit, decommissioned in 2023.
- GSSAP 3. Launched in 2016, on orbit, active.
- GSSAP 4. Launched in 2016, on orbit, active.
- GSSAP 5. Launched in 2022, on orbit, active.
- GSSAP 6. Launched in 2022, on orbit, active.

Orbit Altitude: Near-geosynchronous at 22,300 miles.
Power: Solar panels.

Tech. Sgt. J.T. Armstrong/USAF

SATELLITE CONTROL NETWORK (SCN)

Satellite Control

Brief: The Satellite Control Network provides satellite command and control capabilities for U.S. military and other government satellites. The system includes a network of 19 globally distributed parabolic antennas spread across seven locations around the world. The SCN supports tracking, telemetry, and commanding functions, ensuring that satellites remain in the proper orbit and are performing as designed. These functions are accomplished through the network of ground stations, ground antennas, and communication links between the control centers, antennas, and satellites, strategically located around the world. The SCN is currently operating at high utilization rates while facing increasing demand. To address this, the Space Force is pursuing a range of modernization and augmentation efforts. In 2022, the Space RCO awarded BlueHalo a $1.4 billion contract to replace as many as 12 SCN parabolic satellite dishes with electronic phased array antennas that will be able to talk to up to 20 satellites at a time rather than one. Delivery of all 12 dishes is expected between late

2026-2030. In July 2024, the Space Force awarded Akima's subsidiary Five Rivers Analytics a $480 million 10-year contract to support the Satellite Control Network and help integrate new technologies into the system as they emerge. The Space Force is also exploring working with other federal agencies through Federal Augmentation Services (FAS) program to upgrade and utilize existing civil ground system infrastructure to support the SCN. The Satellite Control Network is operated by Space Delta 6's 21st, 22nd, and 23rd Space Operations Squadrons (SOPS). The 22nd SOPS functions as the primary interface with SCN users, including scheduling satellite contacts. The 21st and 23rd SOPS execute operations and maintenance of SCN antenna systems and tracking stations in the western and eastern hemispheres, respectively.

Contractors: Lockheed Aircraft Corp. (developed as part of the WS-117L program); Philco Corp. (subcontractor to Lockheed and then prime for the development of the remote tracking stations, Akima; (Five Rivers Analytics) (sustainment and modernization); BlueHalo (SCAR development).
Operator/Location: Delta 6, SpOC Schriever SFB, Colo.
- Vandenberg Tracking Station (VTS) - Vandenberg SFB, Calif. (alternate control center), 21nd SOP.
- Hawaii Tracking Station (HTS), Kaena Pt., Hawaii, 21st SOP.
- Guam Tracking Station (GTS), Andersen AFB, Guam, 21st SOP.
- Diego Garcia Station (DGS), Diego Garcia Island, 21st SOP.
- Colorado Tracking Station (CTS), Schriever SFB, Colo. (primary control center), 22nd SOP.
- Pituffik Tracking Station (PTS), Thule AB, Greenland, 23rd SOP
- Telemetry & Command Squadron (TCS), Oakhanger, U.K., 23st SOP
- New Hampshire Tracking Station (NHS), New Boston SFS, N.H., 23rd SOP

IOC: 1959.
Active Systems: 19 parabolic antennas and two command posts at eight worldwide locations.

Courtesy

NAVSTAR GLOBAL POSITIONING SYSTEM (GPS)

Worldwide Navigation, Timing, and Velocity Data

Brief: GPS supplies space-based military and civil radio-positioning for geolocation, navigation, and timing. It is a fundamental enabler of precision bombing, CSAR, mapping, and rendezvous. It provides accurate and uninterrupted 3D (latitude, longitude, and altitude) position, velocity, and time data. The last of the GPS Block IIA satellites, launched between 1990 and 1997 was decommissioned in 2020. GPS Block IIR and IIR-M (modernized) included 21 vehicles launched between 2005 and 2009. Modernization upgrades included two new signals, enhanced encryption, anti-jamming capabilities, a second civil signal, and electromagnetic pulse sensors that form part of the U.S. Nuclear Detonation Detection System (NDS). GPS Block IIF is a follow-on to IIR-M. Upgrades include extended design life, faster processors, and improved anti-jam technology and accuracy, a new military signal, and a second and third dedicated civil signal. The GPS Block IIIA, first launched on Dec. 23, 2018, has improved accuracy, availability, and integrity, and incorporates a steerable, high-power, anti-jam capability. Lockheed Martin completed Block IIIA production at SV-10 in 2022. The company was awarded a follow-on contract for Block IIIF SV-11 and SV-12 as well as up to 22 additional vehicles in 2018. USSF executed options for SV-13 and SV-14 in October 2020, SV-15 to SV-17 in November 2021, and SV-18 through SV-20 in November 2022. Block IIIF will add a hosted search and rescue payload, and a geographically targetable high-power military signal. USSF is working to field the delayed Next-Generation Operational Control Segment (OCX), which will enable advanced GPS III features. The launch and on-orbit check segment of OCX went operational in 2017, but concurrent Blocks 1 and 2 enable use of modernized civil, aviation, military signals, and advanced cyber defenses have been further delayed and are now not expected until mid-2025 or beyond. OCX is one of the last key elements to GPS Block III reaching IOC. USSF launched GPS III SV-7 on Dec. 16, 2024, and SV- 8 is planned for an undetermined launch date in 2025. The first IIIF is slated to be launch-ready by 2026.

Contractors: Boeing (IIF); Lockheed Martin (IIR, IIR-M, III/IIIF).
Operator/Location: USSF SpOC, Space Delta 8 (DEL 8), 2nd Space Operations Squadron (2 SOPS), Schriever SFB, Colo.
First Launch: Feb. 22, 1978.
IOC: Dec. 9, 1993.
Design Life: 7.5 yr (IIR/IIR-M); 12 yr (IIF); 15 yr (IIIA).
Launch Vehicle: Delta II, Delta IV, Falcon 9.
Constellation: 31 spacecraft (not including decommissioned or on-orbit spares).
Active Satellites:
- GPS Block IIR. Launched 1997 to 2004; six active.
- GPS Block IIR-M. Launched 2005 to 2009; seven active.
- GPS Block IIF. Launched 2010 to 2016; 12 active.
- GPS Block IIIA/IIIF. New generation launched in 2018; six active.

Dimensions: (IIR/IIR-M) 5 x 6.3 x 6.25 ft, span incl solar panels 38 ft; (IIF) 9.6 x 6.5 x 12.9 ft, span incl solar panels 43.1 ft.
Weight: On orbit, 2,370 lb (IIR/IIR-M); 3,439 lb (IIF).
Performance: Orbits the Earth every 12 hr, emitting continuous signals, providing time to within one-millionth of a second, velocity within a fraction of a mile per hour, and location to within a few feet.
Orbit Altitude: Medium-Earth Orbit (MEO) at between 10,988 and 12,550 miles.
Power: Solar panels generating 1,136 watts (IIR/IIR-M); up to 2,900 watts (IIF).

DOD

COBRA DANE

Missile Warning/Tracking

Brief: The Cobra Dane Radar Upgrade serves as an advanced L-band radar installation at Eareckson Air Station on Shemya Island, Alaska. Originally engineered to monitor Soviet missile tests, the system underwent significant enhancements in 2004 to incorporate missile defense capabilities. Cobra Dane's primary function involves gathering radar metric and signature data from foreign ballistic missile activities during their flight paths, as well as monitoring space launches to support treaty verification, force modernization, and missile defense initiatives. The system also conducts space surveillance, tracking both cataloged and uncatalogued satellites in low-Earth orbit to enhance Space Domain Awareness operations. The sys-

tem's impressive detection range extends to 2,000 miles, delivering missile tracking and classification data with sufficient precision to authorize interceptor launches from the Ground Midcourse Defense system and provide target updates during interceptor flight. With its phased-array technology, Cobra Dane can simultaneously track multiple objects and automatically switches to Missile Defense mode when detecting threatening missiles or receiving alert notifications. During standard operations, it focuses on space surveillance activities. Initially developed for intelligence collection supporting SALT II arms limitation treaty verification, Cobra Dane transitioned from the Missile Defense Agency to Air Force control in February 2009. By 2015, operational oversight shifted to the Air Force Life Cycle Management Center Battle Management Directorate, with Raytheon securing a maintenance contract in 2016. Currently, the 13th Space Warning Squadron provides operational support for the radar's missile defense and space domain awareness missions.

Contractor: Raytheon.
Operator/Location: 13th Space Warning Squadron, Space Delta 4 (Delta 4), SpOC, Eareckson Air Station, Alaska.
IOC: 1976 operational for missile tracking; upgraded for missile defense in 2004.
Active Systems: One radar site.

DEFENSE SUPPORT PROGRAM (DSP)

Strategic and Tactical Launch Detection

Brief: DSP provides ballistic missile early warning and is a key part of North American and theater early warning systems. It is capable of detecting missile launches and nuclear detonations and was initially meant to watch the Soviet military. It was used extensively in the 1991 Gulf War to detect Iraqi theater missile launches against coalition forces and allies in the region. The 23rd and final DSP satellite launched in December 2007 but malfunctioned and began drifting outside its intended orbit in 2008. Block 5 is the latest variant and is more survivable than predecessors. It includes a medium wavelength IR sensor for more mission utility and accommodates 6,000 detectors. The constellation hosts X-ray, optical, and radiation sensors that form a key part of the Radiation Detection Capability (RADEC) supporting the U.S. Nuclear Detonation Detection System (USNDS). USNDS is capable of near-real-time atmospheric and near-space detection and location of nuclear blasts supporting tactical warning, nuclear forces, space control, treaty monitoring, and classified missions. Nine Block 5 satellites were deployed between 1989 and 2007. SBIRS is integrated with DSP, augments its role, and is designed to eventually replace the constellation on orbit. The constellations jointly enabled early detection of ballistic missiles launched by Iran against U.S. forces at Al Asad AB, Iraq, on Jan. 7, 2020, reducing casualties.

Contractors: Northrop Grumman (formerly TRW); Aerojet.
Operator/Location: USSF SpOC, Space Delta 4 (DEL 4), 2nd Space Warning Squadron; Buckley SFB, Colo.; Joint Tactical Ground Stations (JTAGS) located in Japan, Italy, South Korea, and Qatar.
First Launch: November 1970.
IOC: Circa 1972.
Design Life: Three-year requirement and five-year goal.
Launch Vehicle: Titan IV with inertial upper stage; Delta IV Heavy NSSL.
Constellation: 23 deployed/five operational.
Active Satellites:
- DSP-18. Launched in 1997, on orbit and operational.
- DSP-19. Launched in 1999, on orbit and operational.
- DSP-20. Launched in 2000, on orbit and operational.
- DSP-21. Launched in 2001, on orbit and operational.
- DSP-22. Launched in 2004, on orbit and operational.
- DSP-23. Launched in 2007, on orbit and nonoperational.

Dimensions: Diameter 22 ft, height 32.8 ft, with paddles deployed.
Weight: Approx. 5,200 lb.

LONG RANGE DISCRIMINATION RADAR (LRDR)

Missile Warning/Tracking

Brief: The Long Range Discrimination Radar (LRDR) is an advanced S-band radar system designed to distinguish between enemy intercontinental ballistic missiles (ICBMs) and decoys, serving as a crucial component in the defense of the American homeland. The system is based at Clear Space Force Station in Alaska and will be operated by the U.S., Space Force upon full operational acceptance, which is scheduled for the second quarter of fiscal 2025. The LRDR serves as a critical piece of a layered defense system for the United States. It supports the ballistic missile interceptors belonging to the Ground-Based Midcourse Defense system, which are primarily designed to counter missile threats from nations such as Iran and North Korea. In addition to its primary mission of missile defense, the LRDR will also track objects in space, providing space domain awareness capabilities. The S-band radar system is specifically designed to distinguish between enemy ICBMs and decoys. Built by Lockheed Martin, the LRDR was initially fielded at Clear Space Force Station near central Alaska in late 2021. However, the system has some delays in its operational timeline. A critical assessment test, Flight Test Other-26 (FTX-26), was rescheduled to 2025 after a "target anomaly" canceled the previous year's planned test. Currently, the radar is in transition to full operational status with the U.S. Space Force. Final acceptance by the Space Force is contingent on successful testing of its missile track capability. The radar has already completed a Space Domain Awareness data collection event in January 2024, proving its SDA capability.

Contractor: Lockheed Martin.
Operator/Location: U.S. Space Force; Clear Space Force Station, Alaska.
- 7th Space Warning Squadron, space Delta 4 (Delta 4), SpOC, Beale AFB, Calif. (remotely operate).
- 13th Space Warning Squadron, Space Delta 4 (Delta 4), SpOC, Clear SFS, Alaska.

First Deployment: Late 2021.
IOC: Planned for mid-2025.
Active Systems: One radar.

PERIMETER ACQUISITION RADAR ATTACK CHARACTERIZATION (PARCS)

Missile Warning/Tracking

Brief: PARCS is a sophisticated UHF-phased-array radar system designed for missile defense and space surveillance, operated by the 10th Space Warning Squadron at Cavalier Space Force Station in North Dakota. The system serves as a critical early warning installation, monitoring for potential sea-launched and ICBM ballistic missile threats while providing crucial surveillance data to military command centers. Its capabilities enable comprehensive threat assessment and timely information sharing with defense authorities. The PARCS installation employs advanced radar technology to track a significant portion of Earth-orbiting objects, with its specialized array oriented toward Hudson Bay to maximize coverage of potential threat vectors. Beyond missile defense, PARCS contributes valuable data about space activities as part of the broader space surveillance network. The system processes tens of thousands of tracking operations daily, detecting everything from large satellites to space debris. PARCS originated as a component of the Army's Safeguard missile defense program, but found continued utility in Air Force operations after the original system was decommissioned, transitioning to focus on missile warning and space surveillance. The Space Force maintains PARCS through contracted support services, with a substantial investment in its continued operation and maintenance.

Contractors: Western Electric Co. (prime contractor); InDyne (current maintenance contract).
Operator/Location: USSF 10th Space Warning Squadron; Cavalier Space Force Station, N.D.
IOC: 1976.
Active Systems: One radar site.

PROLIFERATED WARFIGHTER SPACE ARCHITECTURE (TRANCHE 0)

Missile Warning/Tracking

Brief: Tranche 0 of the Proliferated Warfighter Space Architecture (PWSA) demonstrates the feasibility of a proliferated satellite architecture in cost, schedule, and scalability for beyond line of sight targeting and advanced missile detection and tracking The system includes a total of 28 optically connected space vehicles divided into two main components: Transport Layer (20) and Tracking Layer (8). The Transport Layer serves as the data backbone, connecting various satellites to each other and to warfighters, while the Tracking Layer provides missile warning and tracking capabilities. The Transport Layer consists of two configurations: 13 Group A mesh nodes equipped with two optical communications terminals each and

radio frequency receive/transmit capability, and 7 Group B vehicles that also include a tactical data link receive/transmit capability able to connect to Link-16 transmitters. The Tracking Layer includes 8 SVs equipped with wide field of view sensor payloads and two OCTs each. Together, these satellites demonstrate low-latency data connectivity, beyond line of sight targeting, missile warning/tracking, hypersonic glide vehicle detection, and alternate position, navigation & timing (PNT) capabilities.

Contractors: York Space Systems (prime); Lockheed Martin (prime); SpaceX (prime); L3Harris (prime); Leidos (payload subcontractor for SpaceX); Tyvak (bus subcontractor for LMCO); Moog (bus subcontractor for L3Harris).
Operator/Location: Grand Forks AFB, N.D.; Redstone Arsenal, Ala.
Acquiring Organization: Space Development Agency.
First Launch: April 2, 2023.
IOC: Sep 4, 2024 (SpaceX).
Launch Vehicle: Falcon 9.
Constellation: 20 LEO transport layer sats, 8 LEO tracking layer sats.
Active Satellites:
- 13 Group A transport layer satellites, active.
- 7 Group B transport layer satellites, active.
- 8 tracking layer satellites, active.

Weight: ~500 lbs.
Orbit Altitude: LEO.
Power: Solar array and batteries.

SPACE-BASED INFRARED SYSTEM (SBIRS)

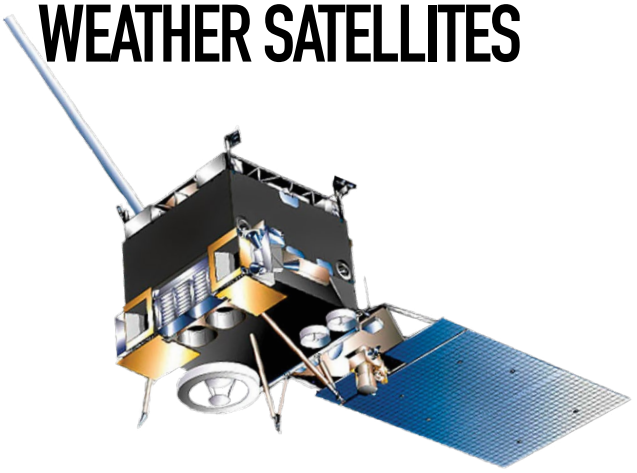
Space-based Surveillance/Missile Warning

Brief: SBIRS provides advanced space surveillance and missile warning, battlespace characterization, and technical intelligence gathering. It is the follow-on to the Defense Support Program satellite. The system includes IR sensor payloads on host satellites in highly elliptical orbit (HEO), two IR sensors each on dedicated satellites in geosynchronous Earth orbit (GEO), and ground assets. The HEO sensor detects launch of submarine-launched ballistic missiles (SLBMs) from the North Pole region and can be tasked for other IR detection missions. GEO scanning IR sensor performs the strategic missile warning mission, global technical intelligence, and initial phase for the strategic missile defense mission, providing two times the revisit rate and three times the sensitivity of DSP. GEO-5 and -6 are based on a modernized spacecraft that will begin migration to the next-generation Enterprise Ground Service (EGS), consolidating control of multiple systems. USSF also awarded Raytheon a contract in 2020 to modernize ground data processing. The Future Operationally Resilient Ground Evolution (FORGE) system will serve both SBIRS and the future Next-Generation Overhead Persistent Infrared (OPIR) system. OPIR will comprise three GEO satellites built by Lockheed Martin and two polar HEO sensors from Northrop Grumman. Delivery of the first OPIR GEO satellite originally planned for launch in FY25 is facing delays due to payload issues. The first HEO sensors are scheduled for delivery in FY28. The final SBIRS GEO satellite (GEO-6) successfully blasted off from Cape Canaveral in 2022 and was operationally accepted March 24, 2023. GEO-5 and GEO-6 will replace the oldest satellites on orbit. SBIRS and DSP provided warning to U.S. and Israeli forces of Iranian strikes in April and October 2024, enabling defense against the largest missile attacks in history.

Contractors: Lockheed Martin (prime contractor); Northrop Grumman (payload); Raytheon (data processing modernization).
Operator/Location: USSF SpOC, Space Delta 4 (DEL 4); Buckley SFB, Colo; (JTAGS) located in Japan, Italy, South Korea, and Qatar.
First Launch: GEO-1, May 2011.
IOC: HEO-1, Dec. 5, 2008. (Increment 1, Dec. 8, 2001).
Launch Vehicle: Atlas V (GEO).
Constellation: Six GEO sats, two HEO sensors and two HEO on-orbit reserve (hosted).
Active Satellites/Payloads:
- SBIRS HEO-1. Payload operational in 2008; on-orbit reserve.
- SBIRS HEO-2. Payload operational in 2009; on-orbit reserve.
- SBIRS HEO-3. Payload operational in 2015; active.
- SBIRS HEO-4. Payload operational in 2017; active.
- SBIRS GEO-1. Launched in 2011; active.
- SBIRS GEO-2. Launched in 2013; active.
- SBIRS GEO-3. Launched in 2017; active.
- SBIRS GEO-4. Launched in 2018; active.
- SBIRS GEO-5. Launched in 2021; active.
- SBIRS GEO-6. Launched in 2022; active.

Dimensions: 49 x 22 x 20 ft (GEO on orbit); 7 x 4 x 3 ft (HEO sensor).
Weight: 5,525 lb (GEO on orbit); 530 lb (HEO sensor).
Orbit Altitude: Geosynchronous (GEO satellites) and highly elliptical (HEO sensors).
Power: Solar array, 2,435 watts (GEO), batteries.

WEATHER SATELLITES



Space Operations Command

ELECTRO-OPTICAL/INFRARED WEATHER SYSTEM-GEOSTATIONARY (EWS-G)

Strategic and Tactical Launch Detection

Brief: EWS-G is an environmental data collection constellation for military weather forecasting over the Indian Ocean region. The system uses EO/IR sensors to image cloud layers and analyze environmental conditions in support of military operations and planning. EWS-G uses a Solar X-ray Imager (SXI) to map cloud cover in tandem with a sounding sensor that measures vertical temperature, humidity, and ozone layers. The satellites are also equipped with radiation and energetic particle sensors to monitor solar activity and electromagnetic "space weather," as well as a search and rescue transponder to extend aircraft, vessel, and personnel distress beacons. Data is transmitted to a Remote Ground Station (RGS) in Dongara, Australia, and relayed to DOD weather centers for analysis, forecasting, and dissemination to tactical users. The first satellite, EWS-G1 was launched as the National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES)-13 in 2006. It was replaced on orbit in 2017 and subsequently transferred to the USSF to fill a gap in meteorological coverage in September 2020. EWS-G1 reached the end of its planned service life in February 2024, and USSF secured transfer of a second satellite (former GOES-15) redesignated EWS-2, which was maneuvered to a new geostationary orbit over the Indian Ocean in 2023. EWS-2 will provide coverage through 2030 or beyond. An Orion Space Systems cubesat launched as a technology demonstrator on March 4, 2024, and General Atomics Electromagnetic Systems is developing a full-scale purpose-built EWS platform planned for launch in 2025. The company is on contract to deliver an initial two satellites to begin replacing DMSP alongside the WSF-M satellites. USSF estimates the DMSP constellation will reach the end of its useful life by 2026.

Contractors: Boeing; Orion Space Solutions (cubesat demonstrator); General Atomics Electromagnetic Systems (future EWS satellite).
Operator/Location: USSF SpOC, Space Delta 2 (DEL 2), 19th Space Defense Squadron (19 SDS), NAF Dahlgren, Va.; National Oceanic and Atmospheric Administration Wallops Command and Data Acquisition Station (WCDAS), Va.; NOAA Operations Facility, Suitland, Md. (backup).
First Launch: May 24, 2006.
IOC: 2020 (with USSF).
Design Life: 14 yrs.
Launch Vehicle: Delta IV.
Constellation: Four low-Earth orbit (LEO).
Active Satellites:
- EWS-G1. Formerly NOAA GEOS-13, launched in 2006; active.
- EWS-G2. Formerly NOAA GEOS-15, launched in 2010; active.
- EWS-Cubesat. Sensor technology demonstrator, launched in 2024; active .

Dimensions: 13.7 x 6.16 ft x 9.5 ft with 27.5 ft solar array (deployed).
Weight: 7,075 lb at launch.
Performance: Geostationary orbit; provides constant near-real-time coverage of the Indian Ocean region.
Orbit Altitude: 22,236 miles.
Power: Solar array generating 2,300 watts.

DEFENSE METEOROLOGICAL SATELLITE PROGRAM (DMSP)

Space and Earth Environmental Data Collection

Brief: DMSP is tasked with environmental data collection for worldwide, military weather forecasting. It provides timely and high-quality weather information to strategic and tactical combat units. DMSP uses an operational line-scan sensor to image cloud cover in the visible and IR spectrum to analyze cloud patterns. It is equipped with microwave imagers and

USAF

sounders and a suite of space environment sensors that provide critical land, sea, and space data. Block 5D-3 improved spacecraft bus and sensors for longer and more capable missions. Six operational DMSP satellites now survey the entire Earth four times a day. DMSP-19 most recently launched in 2014. The vehicle subsequently suffered a power failure in early 2016, rendering it uncontrollable. Data from the craft remain usable until its orbit decays. Congress canceled the DMSP program before the final spacecraft (DMSP-20) could be launched. USSF is replacing DMSP with a combination of the Weather System Follow-On-Microwave (WSF-M) which launched its first satellite in April 2024, and the future Electro-Optical/Infrared Weather System (EWS).

Contractors: Lockheed Martin; Northrop Grumman.
Operator/Location: National Oceanic and Atmospheric Administration; NOAA Operations Facility, Suitland, Md.; Schriever SFB, Colo. (backup).
First Launch: May 23, 1962.
IOC: 1965.
Design Life: Five yr (Block 5D-3).
Launch Vehicle: Delta IV; Atlas V.
Constellation: Four low-Earth orbit (LEO).
Active Satellites:
▪Block 5D-3. Improved spacecraft bus and sensors for longer, more capable missions.
Dimensions: Length 25 ft (with array deployed), width 4 ft.
Weight: 2,545 lb, incl. 772-lb sensor; 2,270 lb with 592-lb sensor payload.
Performance: Polar orbits; covers Earth in about 6 hrs; primary sensor scans 1,800-mile-wide area.
Orbit Altitude: Approx. 527 miles.
Power: Solar arrays generating 1,200-1,300 watts.

WEATHER SYSTEM FOLLOW-ON-MICROWAVE (WSF-M)

Space and Environmental Data Collection

Brief: WSF-M is the Defense Department's next-generation space-based meteorological satellite specifically designed to fill key gaps in ocean surface winds, tropical cyclone intensity, and electromagnetic "space weather" monitoring in LEO. WSF-M's payload includes two main sensors. The passive microwave radiometer utilizes a 6-foot antenna array to monitor winds, cloud cover, snow depth, sea ice, and soil moisture, augmenting the Electro-Optical/Infrared Weather System (EWS) satellite system. The Energetic Charged Particle sensor, meanwhile, monitors electromagnetic "space weather in LEO" which can disrupt communications and electronic systems. WFS-M data is utilized by the Joint Typhoon Warning Center to improve the tracking of potentially damaging tropical storms as well as provide data for forecasting and mission planning to military users in real-time. USAF awarded Ball Aerospace a development contract in 2017, and most recently ordered a second satellite (SV-2) in January 2023. The first satellite launched from Vandenberg on April 11, 2024. WSF-M along with EWS-G are replacing DMSP which will reach its planned end-of-service date next year.

Contractors: Ball Aerospace (satellite); BAE Systems (systems and sensor integration).
Operator/Location: USSF SpOC, Space Delta 2 (DEL 2), 19th Space Defense Squadron (19 SDS), NAF Dahlgren, Va.
First Launch: April 11, 2024.
IOC: N/A.
Design Life: Unk.
Launch Vehicle: Falcon 9.
Constellation: One low-Earth orbit (LEO).
Active Satellites:
▪WSF-M SV-1. First satellite, launched in 2024; active.
Dimensions: 7.2 x 5.6 ft x 4.6 ft, not including deployed solar array.
Weight: 2,645 lb at launch.
Performance: Sun-synchronous orbit.
Altitude: Approx 517 miles.
Power: Solar array and batteries.

ELECTRONIC WARFARE

Airman 1st Class Andrew Bertain

COUNTER COMMUNICATIONS SYSTEM (CCS)

Electronic Warfare

Brief: The Counter Communications System is a transportable space electronic warfare system that reversibly denies adversary satellite communications. It is the first space control platform acknowledged by the Space Force and provides quick reaction capability with direct operational support to the warfighter. First introduced in 2004, the CCS has undergone several upgrades, with Block 10.2 achieving Initial Operating Capability (IOC) in March 2020. Currently, the CCS is undergoing a "step-change" capability upgrade as it transitions to the "Meadowland" variant.

Contractor: L3Harris.
Operator/Location:
▪ 4th Electromagnetic Warfare Squadron, Space Delta 3 (DEL 3), Space Operations Command. Peterson Space Force Base, Colo.
▪ 216 Electromagnetic Warfare Squadron, California National Guard, Beale AFB, Calif.
▪ 138 Electromagnetic Warfare Squadron, Colorado National Guard, Peterson SFB, Colo.
▪ 114th Electromagnetic Warfare Squadron , Florida National Guard, Cape Canaveral SFS, Fla.
IOC: 2004.
Active Systems: 16 total (2 already transitioned to Meadowlands configuration).
Dimensions: Mobile, transportable system.
Weight: Unknown.

MEADOWLANDS

Electronic Warfare

Brief: Meadowlands is a ground-based satellite jamming system that provides advanced electronic warfare capabilities to disrupt enemy communications satellites. It is a major "step change" level upgrade to the Space Force's first acknowledged offensive counterspace system, the Counter Communication System (CCS), which has been operational since 2004. The system is a mobile electronic warfare platform designed for interfering with enemy satellite communications through radio signal jamming. Meadowlands features expanded frequency range capabilities including multifrequency jamming in S-band and X-band, increased mobility with a significantly smaller footprint than its predecessor and incorporates remote command and control functionality to reduce the number of personnel required at the antenna site. The system uses radio signals to jam enemy communications, and the modernized version has an expanded frequency range, which improves its ability to interfere. The system is also lighter weight than its predecessor and has an open architecture that will allow for more regular software updates in the future. Space Force formally accepted delivery of the first mobile Meadowlands satellite jammer from prime contractor L3Harris in April 2025, with the delivery occurring approximately six months earlier than previously planned. L3Harris won a contract in January 2019 for conversion of five CCS to Meadowlands standard. A production contract was signed in October 2021 and runs through January 2028 for over 20 units and associated training systems. This will likely include the upgrading its entire inventory of 11 CCS to the Meadowlands standard.

Contractor: L3Harris.
Operator/Location: Space Domain Awareness and Combat Power, SSC, Los Angeles AFB, Calif.
First Delivery: Delivered for testing, April 2025.
IOC: N/A.
Active Systems: First two units delivered April 2025.
Dimensions: Significantly smaller than CCS.
Weight: Lighter than predecessor (specific weight not provided).

SpaceX

FALCON 9

Launch

Brief: Falcon 9 is SpaceX's workhorse partially reusable two-stage orbital rocket that has revolutionized the launch industry with its reusability and high launch cadence. Since its debut in 2010, Falcon 9 has become the most frequently launched U.S. orbital rocket, dramatically lowering launch costs while maintaining high reliability. In 2020, it became the first commercial rocket to launch humans to orbit and continues to dominate the commercial launch market.

First Launch: June 4, 2010.
Total Launches (through FY 2024): 474.
Launches in FY 24: 119.
Class: Medium-lift partially reusable launch vehicle.
Company: SpaceX.
Payload to LEO: Up to 22,800 kg (50,265 lb).
Payload to GEO: Up to 8,300 kg (18,300 lb) to GTO.
Engine Type: Nine Merlin 1D engines (first stage), one Merlin Vacuum engine (second stage).
NSSL Lane 2 Certified: Yes.

FALCON HEAVY

Launch

Brief: Falcon Heavy is currently one of the world's most powerful operational rockets, composed of three Falcon 9 first stages working together as a heavy-lift launch vehicle. With 27 Merlin engines generating more than 5 million pounds of thrust at liftoff, Falcon Heavy can deliver large payloads to Earth orbit and beyond, including direct insertion into geosynchronous orbit and interplanetary trajectories.

First Launch: Feb. 6, 2018.
Total Launches (through FY 2024): 11.
Launches in FY 24: Three.
Class: Heavy-lift partially reusable launch vehicle.
Company: SpaceX.
Payload to LEO: Up to 63,800 kg (140,660 lb).
Payload to GEO: Up to 26,700 kg (58,860 lb) to GTO.
Engine Type: 27 Merlin engines (three Falcon 9 cores), one Merlin Vacuum engine (second stage).
NSSL Lane 2 Certified: Yes.

VULCAN

Launch

Brief: Vulcan Centaur is ULA's next-generation heavy-lift launch vehicle, designed to replace Atlas V and Delta IV rockets. Utilizing advanced technology from both legacy platforms along with innovations like Blue Origin's BE-4 engines, Vulcan offers increased capabilities at competitive prices. Primarily developed to meet the requirements of the National Security Space Launch program, Vulcan completed its maiden flight in January 2024.

First Launch: Jan. 8, 2024.
Total Launches (through FY 2024): 0, (subsequently 2 flights have occurred till May 2025).
Launches in FY 24: 0.
Class: Heavy-lift expendable launch vehicle.
Company: United Launch Alliance (ULA).
Payload to LEO: Up to 27,200 kg (60,000 lb).
Payload to GEO: Up to 14,400 kg (32,000 lb) to GTO.
Engine Type: Two Blue Origin BE-4 engines (first stage), two Aerojet Rocketdyne RL10C engines (upper stage).
NSSL Lane 2 Certified: March 2025, after two test flights.

NEW GLENN

Launch

Brief: New Glenn is Blue Origin's orbital heavy-lift launch vehicle, representing the company's entry into the orbital launch market. Named after astronaut John Glenn, this partially reusable rocket features a reusable first stage powered by seven BE-4 engines designed to land on an ocean platform and operate for a minimum of 25 flights. With its 7-meter diameter fairing and impressive payload capacity, New Glenn aims to serve commercial, civil, and national security missions.

First Launch: Jan. 16, 2025 (successful first orbital flight).
Total Launches (through FY 2024): 0, (first flight in mission in January 2025).
Launches in FY 24: 0, (first flight in mission in January 2025).
Class: Heavy-lift partially reusable launch vehicle.
Company: Blue Origin.
Payload to LEO: Up to 45,000 kg (99,000 lb).
Payload to GEO: Up to 13,000 kg (28,600 lb) to GTO.
Engine Type: Seven BE-4 engines (first stage), two BE-3U engines (second stage).
NSSL Lane 2 Certified: In certification process, undergoing demonstration flights.

EXPERIMENTAL SYSTEMS

X-37B Orbital test Vehicle on P. 143