U.S. Space Force

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The U.S. Space Force (USSF) was created with enactment of the fiscal year (FY) 2020 National Defense Authorization Act (NDAA) on December 20, 2019.[1] Established as the fifth uniformed service within the Department of Defense (DOD) and the second service within the Department of the Air Force (DAF), the USSF functions under the direction and leadership of the Secretary of the Air Force. The FY 2020 NDAA specifies that a four-star general will serve as Chief of Space Operations (CSO) and as a full member of the Joint Chiefs of Staff.[2]

The Space Force's mission is to organize, train, and equip forces "to protect U.S. and allied interests in space and to provide space capabilities to the joint force." Its responsibilities include "developing Guardians [military space professionals], acquiring military space systems, maturing the military doctrine for space power, and organizing space forces to present to our Combatant Commands."[3]

A 2001 RAND study estimated that 95 percent of all civilian and commercial space technologies have direct applicability to military systems or are of dual use. That fact and the capabilities that those two sectors bring to the Space Force are critical to an assessment of this new service.[4] The domination of great-power competition in space relies increasingly on the interwoven efforts of all three U.S. sectors—military, civil, and commercial space.

Background

More than any other nation, America has enjoyed the technological advantages of space, and we now rely on it for nearly every aspect of our lives. Banking, commerce, travel, entertainment, the functions of government, and our military all depend on our assets in space.[5]

Though our reliance on our spaceborne systems has been recognized by every President since Dwight Eisenhower in the mid-1950s, various issues kept the United States from developing a single service charged with managing space assets and capabilities. In 1961, the Air Force was named executive agent for space research and development, but at that point, the Army and Navy already had well-established programs.[6] Every Administration sustained this splintered approach for the next six decades, but U.S. space capabilities still advanced at a stunning pace.

The effectiveness of the DOD's space support missions was put on full display during Operation Desert Storm,[7] and adversary nations did much more than take note. They recognized the growing U.S. dependence on space and began to position themselves to move against it.

As early as 2001, a congressionally mandated report warned of our growing dependence on space and the vulnerability of U.S. assets in that domain and ultimately recommended establishing a Space Corps within the DAF.[8] Those recommendations were set aside following the terrorist attacks of September 11, 2001, and by the mid-2010s, the command and control of space had fragmented across at least 60 different DOD offices.[9] All the while, U.S. reliance on the Global Positioning System (GPS) for air, land, and sea maneuver, targeting, and engagement has grown to the point of being nearly universal, exposing a critical vulnerability that our adversaries have moved to exploit.

Both China and Russia have developed doctrine, organizations, and capabilities to challenge U.S. access to and operations in the space domain. Concurrently, their own use of space is expanding significantly. These nations have demonstrated the capability to put American space assets at risk, and until very recently, the United States had not taken

overt steps to protect those systems, much less to develop its own warfighting capability in that domain.

The FY 2017 NDAA mandated that DOD conduct a review of the organization and command and control of space assets within the department.[10] Shortly after the FY 2017 NDAA was enacted, President Donald Trump directed that a Space Force be established within the DAF.[11] Congress concurred and authorized the creation of the USSF with enactment of the FY 2020 NDAA.

An important addition to the U.S. warfighting command structure was the reestablishment of U.S. Space Command as the 11th Combatant Command within the Department of Defense. The mission of Space Command is to conduct "operations in, from, and to space to deter conflict, and if necessary, defeat aggression, deliver space combat power for the joint/combined force, and defend U.S. vital interests with allies and partners."[12]

U.S. Space Force Organization

The USSF Headquarters and Office of the Chief of Space Operations are located in the Pentagon. When Congress authorized the Space Force, it limited its scope to Air Force organizations and personnel located at five major installations:

- The 21st Space Wing at Peterson Air Force Base, Colorado;
- The 30th Space Wing at Vandenberg Air Force Base, California;
- The 45th Space Wing at Patrick Air Force Base, Florida;
- The 50th Space Wing at Schriever Air Force Base, Colorado; and
- The 460th Space Wing at Buckley Air Force Base, Colorado.[13]

Those personnel, organizations, and structures have been or will be restructured and rolled into three major field commands that fall directly under the CSO:

- Space Operations Command (SpOC);
- Space Systems Command (SSC); and
- Space Training and Readiness Command (STARCOM).[14]

These three commands lead the next tier of organizations, called Deltas and Garrisons. Deltas are equivalent to Air Force Groups, are led by a colonel, and are tasked with and responsible for specific missions and operations. Garrisons are also the equivalent of Air Force Groups and support Deltas with functions similar to those of Air Force base-level command. Squadrons are the final level of command and will fall under Deltas and Garrisons.[15]

Space Operations Command. SpOC was established on October 22, 2020, as the first major USSF field command.[16] Currently located at Peterson Air Force Base, Colorado, SpOC is led by a three-star general and is responsible for organizing, training, and equipping space forces assigned to Combatant Commands. The SpOC at Vandenberg Air Force Base, California, was redesignated as SpOC West and continues to conduct operations in support of Combatant Commanders.

Space Systems Command. This command stood up on August 13, 2021, at Los Angeles Air Force Base[17] to oversee the development, acquisition, and maintenance of satellites and ground systems, the procurement of SATCOM and launch services, and investments in next-generation technologies. SSC is led by a three-star general who oversees the Space Force's approximately $15.8 billion annual budget for research, development, test, and evaluation (RDT&E) and the acquisition of new systems.[18] SSC absorbed the Space and Missile Systems Center (SMC), located at Los Angeles Air Force Base, California; the Commercial Satellite Communications Office based in Washington, D.C.;[19] and the Space Vehicles Directorate at Kirkland Air Force Base, New Mexico.[20]

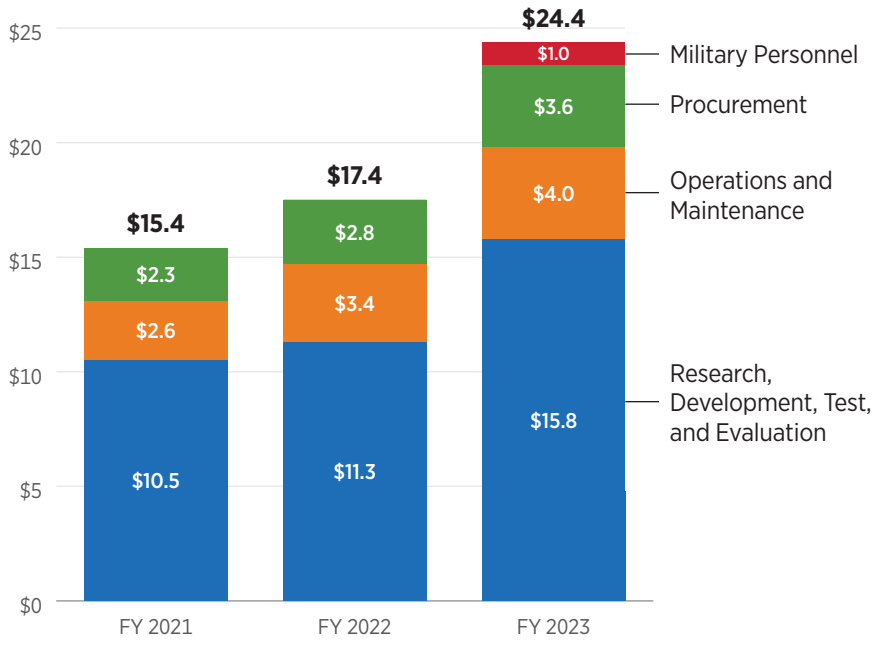
Space Training and Readiness Command. STARCOM is the third USSF field organization and stood up on August 23, 2021, at Peterson Air Force Base in Colorado. It is led by a two-star general and is responsible for the education and training of space professionals.[21]

Personnel. The FY 2023 Air Force budget request supports 8,600 military and 4,927 civilian Space Force personnel, respectively, up from 8,400 military and 4,364 civilian, respectively, in FY 2022, and a total end strength of 13,527, up from 12,764 in FY 2002.[22] The 2020 NDAA specified that only

CHART 10

U.S. Space Force Budget

IN BILLIONS OF DOLLARS



NOTE: U.S. Space Force personnel costs for fiscal years 2021 ($800.3 million) and 2022 ($929.8 million) were funded by the U.S. Air Force budget.

SOURCES: U.S. Air Force budget summaries for fiscal years 2021, 2022, and 2023. For example: Table 3, "U.S. Space Force Budget Summary," in U.S. Department of the Air Force, *Department of the Air Force Fiscal Year 2023 Budget Overview*, p. 6, https://www.safm.hq.af.mil/Portals/84/documents/FY23/SUPPORT_/BOB_28Mar_1125_LoRes.pdf?ver=5nrA8bBfhWoUSrvZ09CeHA%3d%3d (accessed August 18, 2022).

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the Air Force was required to provide personnel for the Space Force, and with the redesignation of Air Force Space Command (AFSPC) as Space Operations Command, approximately 16,000 Air Force active-duty and civilian personnel were assigned to support the USSF.[23]

The Space Force began to accept interservice transfer applications for the first time on June 15, 2022.[24] In June, the Naval Satellite Operations Center (NAVSOC) based at Naval Base Ventura County in Mugu, California, was transferred to the USSF and redesignated as the 10th Space Operations Squadron (SOC). On August 15, 2022, the Army announced the transfer of its satellite communications functions, conducted by the 53rd Signal Battalion, along with approximately 300 uniformed and 200 civilian Army personnel who work those systems. Those personnel are based in Maryland, Hawaii, Germany, and Japan and will remain at those duty locations as the USSF's 53rd Space Operations Squadron. Many of the Army and Navy transfers were supposed to happen at the beginning of FY 2022 but were delayed because of the congressional delay in passing the FY 2022 budget. With the Army's SATCOM mission transfer, the Space Force is now the only DOD organization that conducts satellite and transmission control for the Defense Satellite Communications System (DSCS) and Wideband Global SATCOM (WGS) Satellite constellations.[25]

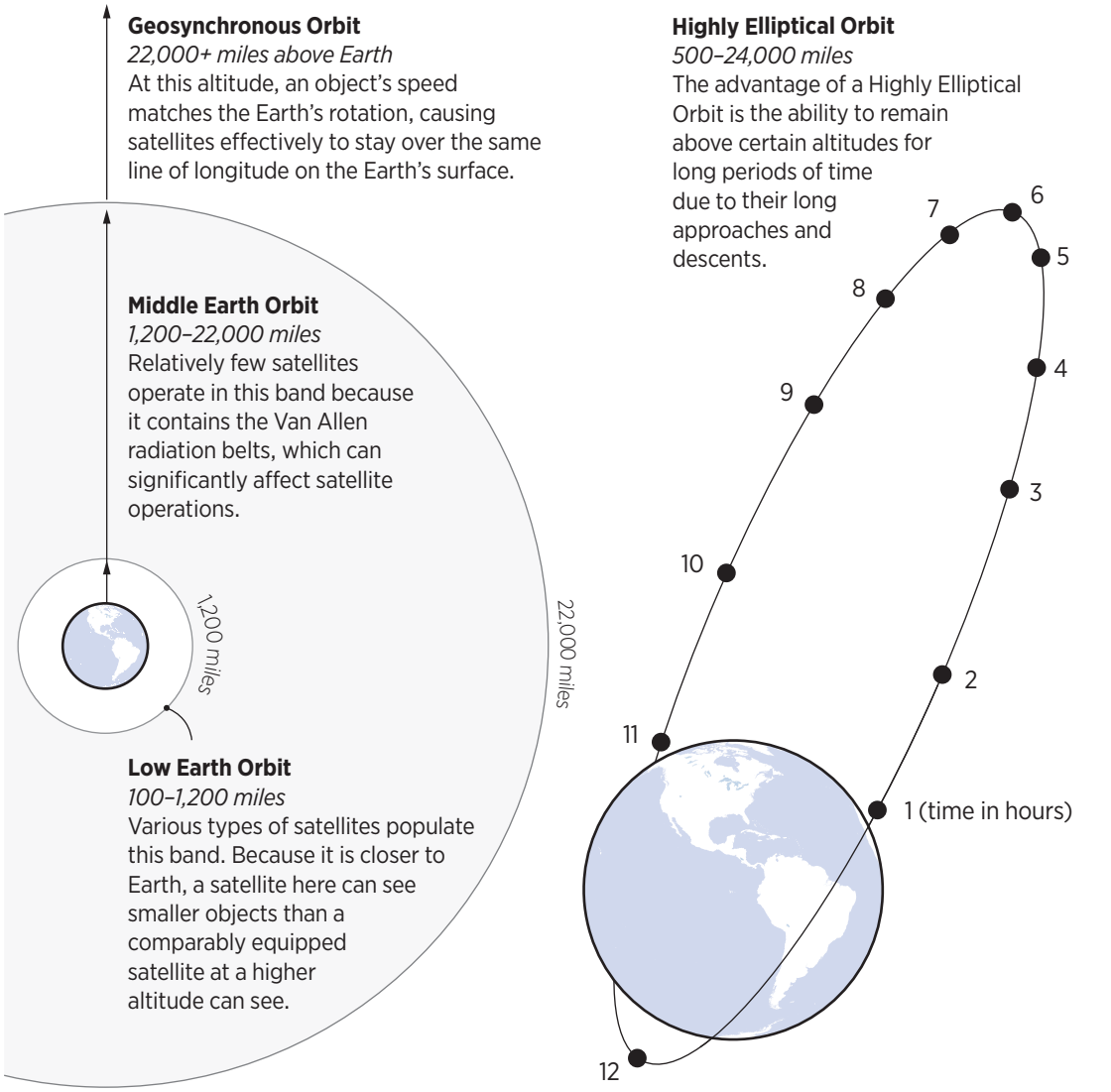
"To officially transfer from one military service to another," according to the USSF, "a military member separates from the current service and commissions or enlists into the new service in their current rank."[26]

Funding

The President's budget request for FY 2023 lays out a relatively robust level of funding for every

FIGURE 4

Types of Earth Orbits



SOURCE: Heritage Foundation research.

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aspect of the new service's mission set. The budget for Operations and Maintenance (O&M) is $4.0 billion; the budget for RDT&E is $15.8 billion; and procurement adds another $3.6 billion for a total of $24.5 billion, a 41 percent increase from FY 2022.[27]

Assuming that the President's budget is fully funded, the Space Force, as noted, will have an authorized end strength of 13,527 military and civilian personnel, an increase of 763 from FY 2022.[28] The combination of robust funding and manpower levels will allow the CSO to continue to focus on building a strong organizational foundation and filling critical billets with the right people.

Capacity

The classified nature of deployed space assets makes listing specific capacity levels within the Space Force portfolio, much less attempting to

assess the service's capability to execute its mission, a challenging exercise. The USSF's position, navigation, and timing (PNT); command and control (C2); communications (Comm); weather; and intelligence, surveillance, and reconnaissance (ISR) satellites are unrivaled and provide extraordinary capabilities. Its space situational awareness (SSA) satellites and terrestrial-based capabilities are also unrivaled, but they are limited and require additional resourcing. Each satellite, satellite constellation, and terrestrial space surveillance site has unique characteristics and an expected life span.

Satellite Constellations

The Space Force's mission is conducted through a network of satellites, ground-based radar, ground stations, and situational awareness nodes. In 2018, the Secretary of the Air Force stated that the service operates 77 satellites that provide information on position, navigation, and timing (PNT), weather, communications, command and control, missile warning, and nuclear detonation that is "vital to national security."[29] An estimated 114 satellites now reside within the Space Force portfolio. (See Table 14).

Global Positioning System (37 Satellites). Perhaps the best-known constellation of satellites under Space Force control is the Global Positioning System, which provides PNT for millions of simultaneous users around the world. It takes 24 of these satellites to provide seamless global coverage, and 31 are operational.[30] Currently, six additional satellites that have been decommissioned serve as on-orbit spares, bringing the total to 37.

GPS III is the latest upgrade to the platform and incorporates a more robust anti-jamming capability. The fifth GPS III satellite was launched into orbit in June 2021.[31] The sixth reportedly is scheduled for launch in January 2023, and the seventh and eighth have been completed and are awaiting their turn in the launch queue.[32] GPS III satellites have a civilian signal that is interoperable with other Global Navigation Satellite Systems (GNSS) such as the European Galileo network and the Japanese Quazi-Zenith Satellite System, adding an impressive level of resiliency to the constellation.[33]

Defense Meteorological Satellite Program (DMSP) (Three Satellites). Defense weather satellites have been collecting weather data and providing forecasts for U.S. military operations since 1962 through the Defense Meteorological Satellite Program (DMSP).[34] Currently, three DMSP satellites[35] are operational and in polar low-Earth orbit (LEO).[36]

The main sensors for these weather satellites are optical, and each provides continuous visual and infrared imagery of cloud cover over an area approximately 1,600 nautical miles wide, enabling complete global coverage of weather features every 14 hours.[37] Launched between 1999 and 2009 with a life expectancy of just five years, they have continued to deliver exceptional data well beyond their expected lifetimes.[38]

Military Strategic and Tactical Relay (Milstar) (Five Satellites). Milstar is a satellite communications (SATCOM) system designed in the 1980s to provide the National Command Authorities (President, Vice President, Secretary of Defense, Joint Chiefs of Staff, and Combatant Commanders) assured, survivable global communications with a low probability of intercept or detection. This constellation was designed to overcome enemy jamming and nuclear effects and was considered the DOD's most robust and reliable SATCOM system when it was fielded. Milstar was fielded from 1993 through 2004 with a designed life of 10 years.[39]

Advanced Extremely High Frequency System (AEHF) (Six Satellites).[40] Like Milstar, AEHF provides and sustains secure, jam-resistant communications and C2 for high-priority military assets located anywhere in the world. Each AEHF satellite provides more capacity than the entire five-satellite Milstar constellation with five times the Milstar data rates, enabling real-time video, battlefield maps, and targeting data for tactical users.[41] The AEHF constellation was launched into geosynchronous orbit (GEO) from 2010–2020 with a satellite design life of 14 years.[42]

Defense Satellite Communications System (DSCS) (Seven Satellites). These satellites provide nuclear-hardened, global communications to the Defense Department, the Department of State, and the National Command Authorities. The system is capable of high data rates and provides anti-jamming capabilities. These satellites were fielded from 1998 through 2003 into GEO with 10-year life spans.[43]

Wideband Global SATCOM (WGS) (10 Satellites). WGS is a joint-service program funded by the U.S. Air Force and U.S. Army, along with international partners Australia and Canada, and is used by all

DOD services as well as National Command Authorities. Once known as the Wideband Gapfiller Satellite,[44] WGS provides Super High Frequency (SHF) wideband communications, using direct broadcast satellite technology to provide C2 for U.S. and allied forces. With solid capabilities that include phased array antennas and digital signal processing technology, this system delivers a flexible architecture with a satellite life span of up to 14 years.

Fleet Satellite Communications System (FLTSATCOM) (Six Satellites).[45] FLTSATCOM is a constellation of five operational satellites used by the Navy, Air Force, and presidential command network. The system was launched into GEO between 1978 and 1989 to serve as a secure communications link between the three users with a design life of five years.[46] This constellation was transferred from the U.S. Navy to the Space Force on June 6, 2022.[47]

Ultra-High Frequency Follow-On (UFO) (10 Satellites). The UFO constellation was designed to replace FLTSATCOM to provide communications for tactical users including aircraft, ships, submarines, and ground forces. UFO provides almost twice the throughput and 10 percent more power per channel than FLTSATCOM. This UFO constellation of satellites was launched into GEO between 1993 and 2003 with a life expectancy of from 14 to 15 years.[48] The system was transferred from the U.S. Navy to the Space Force on June 6, 2022.[49]

Mobile User Objective System (MUOS) (Five Satellites). MUOS is a next-generation narrowband tactical satellite communications system designed for tactical users with the goal of significantly improving ground communications, even for troops in the most remote locations or in buildings with no other satellite access. MUOS satellites were launched into GEO from 2012 through 2016 with a design life of 15 years and provide the ability to provide the transmission of 10 times more information volume than can be transmitted with UFO.[50] This constellation was transferred from the U.S. Navy to the Space Force on June 6, 2022.[51]

Space-Based Infra-Red System (SBIRS) (10 Satellites). SBIRS is an integrated constellation of satellites designed to deliver early missile warning and provide intercept cues for missile defenses. This surveillance network was designed to incorporate three satellites in highly elliptical orbit (HEO) and eight others in GEO, each working in concert with ground-based data processing and command and control centers. Because SBIRS HEO is a retaskable orbit, these satellites can be moved to more optimal orbits/viewpoints as mission requirements dictate. Four SBIRS HEO satellites and six SBIRS GEO satellites are now in orbit (GEO-6, the final satellite in this constellation, was launched into orbit on August 4, 2022).[52]

The funding that was removed from SBIRS was shifted to a new program, Next-Generation Overhead Persistent Infrared (Next-Gen OPIR), which will include a new ground-control system. Fielding of this strategically survivable constellation of missile warning satellites is scheduled to begin sometime in FY 2023.[53]

Defense Support Program (DSP) (Five Satellites). DSP is a classified constellation that was designed to detect launches of intercontinental ballistic missiles (ICBMs) or submarine-launched ballistic missiles (SLBMs) against the U.S. and its allies. Its secondary missions include detection of space launch missions or nuclear weapons testing and detonations, as well as launches of shorter-ranged ballistic missiles. The DSP constellation is in GEO and uses infrared sensors to pick up the heat from missile booster plumes against the Earth's background. Phase 1 placed four satellites in orbit from 1970 through 1973[54] and was followed by Phase 2, which placed six satellites in orbit from 1979–1987.[55] Phase 3 consisted of 10 DSP satellites that were launched from 1989–2007.[56]

Although Phase 3 DSP satellites have long exceeded their design lifetimes, reliability has exceeded expectations. At least five[57] and as many as eight are still providing reliable data and are now integrated with and controlled by the SBIRS program ground station.[58]

Space Situational Awareness Systems

Knowledge of hostile space systems—their locations, their positional history, and how those satellites and other spacecraft are maneuvering in real time—conveys intent and collectively shapes the protocols and counterspace decisions that follow. Space situational awareness is therefore critical to every aspect of defensive and offensive counterspace operations and forms the foundation for DOD counterspace activities.[59]

In addition to adversary systems, other significant threats are in orbit. The National Aeronautics and Space Administration (NASA) estimates that

as many as a half-million objects with diameters between 0.4 inches and four inches are circling the Earth.[60] In August of 2021, the Space Force was tracking some 35,000 objects in LEO alone, but that was before the Russian ASAT test in November of that year that created some 1,500 additional pieces of trackable debris and thousands more that are too small to track.[61] Even very small pieces of debris moving at LEO orbital speeds of between 15,600 and 17,900 miles an hour[62] threaten everything from satellites to the International Space Station.[63]

Maintaining a high level of situational awareness of satellites and debris orbiting across the depth and vast dimensions of potential Earth orbits requires a robust and seamless network of space-based and 23 terrestrial-based sensors, the earthbound portion of which is known collectively as the Space Surveillance Network (SSN). Understanding the capabilities and limitations of that network naturally begins with understanding the numbers and types of space-based and ground-based systems.

Six acknowledged satellites (with four other likely satellites) and six dedicated and 17 collateral or contributing terrestrial-based sensors help to maintain situational awareness of satellites and other objects in space. The satellites, known collectively as the Space-Based Surveillance System (SBSS), operate in concert with ground-based sensors but without their limitations such as suitable weather and sunlight that can blind ground-based optical sensors.

Some satellites track objects and debris fields from LEO. Others operate from a much higher orbital position (GEO) and are capable of maneuvering to perform detailed inspections of orbiting items that are of especially high interest.

Geosynchronous Space Situational Awareness Program (GSSAP) (Six Satellites). This classified surveillance constellation can accurately track and characterize objects in orbit.[64] Operating near GEO, GSSAP satellites are maneuverable and therefore able to perform rendezvous and proximity operations (RPO) on objects of interest in space.[65] Launched in pairs, the first two GSSAP satellites were put in orbit on July 28, 2014; the second two were launched on August 19, 2016; and a third pair was launched on January 21, 2022.[66] Each GSSAP satellite has an estimated life span of seven years.[67]

Space-Based Space Surveillance System-1 (SBSS-1) (One Satellite). The SBSS-1 satellite was launched into LEO in 2010 to detect and track space objects, such as satellites and orbital debris. This satellite has a seven-year life expectancy.[68]

Space Tracking and Surveillance System Advanced Technology Risk Reduction (STSS-ATR) (One Satellite). STSS-ATR is an RDT&E satellite placed in a polar LEO on May 5, 2009, for the Missile Defense Agency (MDA) to test an alternate technology for potential missile defense application.[69]

Space Tracking and Surveillance System (STSS) (Two Satellites). Formerly known as SBIRS-Low, the two STSS satellites carry a very capable set of infrared and visible sensors for detecting and tracking ballistic missiles through all phases of their trajectory. These satellites were launched into LEO in 2009 with programmed life spans of two years.[70]

Terrestrial-Based Sensors (23 Sensors). There are six dedicated, ground-based radar sensors that track satellites and orbital debris, including the Space Fence on Kwajalein Atoll in the South Pacific. Seven collateral radar sensors are part of the network, but their primary mission is to detect and track ICBMs and SLBMs and to test and evaluate other systems.[71] Another 10 contributing SSN sensors controlled by other organizations or agencies provide space surveillance support upon request from the National Space Defense Center (NSDC).[72] The Space Fence radar emits a very narrow, fan-shaped beam in the north–south direction that "paints" satellites and debris from low-Earth orbit as they fly through the radar fan, and it can track objects all the way out to GEO.

Reconnaissance and Imaging Satellites (Number Unknown). Although the history of the Air Force is steeped in these reconnaissance systems, the operational details of each constellation are classified. In the late 1990s and early 2000s, the Air Force moved to develop and field a constellation of space-based radar satellites. That program (known as Lacrosse/Onyx) launched five satellites, each carrying a synthetic aperture radar (SAR) as its prime imaging sensor. Because SAR systems can see through clouds with high resolution, they offer the potential to provide a capability from which it is hard to hide.[73]

Space Launch Capacity

The Space Force manages the National Security Space Launch (NSSL) program, a Major Defense Acquisition Program that acquires launch services

TABLE 13

Space Launches by Country Since 2010

	U.S.	China	Russia	India
2010	17	16	16	3
2011	19	19	20	3
2012	12	19	12	2
2013	19	15	18	3
2014	21	15	22	4
2015	19	19	14	3
2016	24	22	13	7
2017	29	18	13	4
2018	29	39	13	7
2019	20	34	14	6
2020	53	19	21	14
2021	57	51	23	1
2022	101	26	21	5
Total	**420**	**312**	**220**	**62**

NOTE: Figures for 2022 include actual and projected launches.
SOURCE: Space Launch Schedule, https://www.spacelaunchschedule.com/ (accessed August 15, 2022). heritage.org

from private companies to deliver national security satellites into orbit. Currently, the NSSL uses the Atlas V and Delta IV Heavy launch vehicles from United Launch Alliance (ULA) and the Falcon 9 and Falcon Heavy from SpaceX to launch national security payloads.

In 2018, the Air Force awarded three launch services agreements to space launch companies to develop their launch vehicles for a second phase of the NSSL. In 2020, the Space Force awarded two launch services procurement contracts to ULA and SpaceX, and those two vendors will provide space launch services for the Space Force through 2027.[74]

In 2010, four organizations, including NASA, were involved in launching manned and unmanned systems into space. Today, 11 private American corporations are engaged in placing satellites into orbit.[75] In 2022, U.S. companies are scheduled to launch 101 missions into space, and China and Russia are scheduled to conduct 26 and 21 launches, respectively.[76] The numbers for China and Russia are based on launch schedules published for each of those countries and are often misleading. China planned 22 launches in 2021, but it actually executed 51 missions into space, which was just behind the U.S.'s 57 space shots for that same year.[77] America is still outpacing its peers with this vital capability, but the competition appears to be gaining.

Capability

With an estimated 114 satellites in its portfolio, the USSF can meet much of the communications, collection, and imagery demand placed on it by the National Command Authorities and the strategic-level intelligence requirements of the Defense Department. However, getting real-time satellite intelligence to warfighters at the operational and tactical levels is still problematic. The loss of even a small number of those 114 satellites could significantly impact operational capabilities across the DOD.

Backbone Satellites (89 Satellites). In spite of an ever-growing demand, the PNT services offered by GPS are unrivaled in both capacity and capability. With 31 operational GPS satellites in orbit and

TABLE 14

U.S. Satellites in Orbit

System	Function	Satellites
GPS	Positioning, Navigation, and Timing	37
DMSP	Weather	3
Milstar	Communications	5
AEHF	Communications	6
DSCS	Communications	7
WGS	Communications	10
FLTSAT	Communications	6
UFO	Communications	10
MUOS	Communications	5
SBIRS	Missile Warning	10
DSP	Missile Warning	5
GSSAP	Space Surveillance	6
SBSS	Space Surveillance	1
STSS-ATR	Missile Defense and Space Tracking	1
STSS	Missile Defense and Space Tracking	2
Total		**114**

NOTE: Data are current as of July 31, 2022.
SOURCES:

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TABLE 15

U.S. Space Launches by Organization

Company	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Space X	2	0	2	3	6	8	8	18	21	13	27	30	61
Northrup Grumman	2	4	1	5	2	0	2	3	2	3	5	4	5
United Launch Alliance	8	11	10	11	14	12	12	8	8	5	6	5	9
Astra	0	0	0	0	0	0	0	0	1	0	0	1	1
Rocket Lab, LTD	0	0	0	0	0	0	0	0	0	0	2	4	11
Firefly Aerospace	0	0	0	0	0	0	0	0	0	0	0	1	3
NASA	3	3	0	0	0	0	0	0	0	0	0	0	0
Blue Origin	0	0	0	0	0	2	4	0	0	1	1	6	3
Virgin Orbit	0	0	0	0	0	0	0	0	0	0	1	2	3
Terran	0	0	0	0	0	0	0	0	0	0	0	0	1
ABL Space Systems	0	0	0	0	0	0	0	0	0	0	0	0	2
Launcher	0	0	0	0	0	0	0	0	0	0	0	0	1
NASA	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	**15**	**18**	**13**	**19**	**22**	**22**	**26**	**29**	**32**	**22**	**42**	**53**	**101**

NOTES: Figures for 2022 include actual and projected launches. No Blue Origin launch to date has been orbital.
SOURCE: Space Launch Schedule, "USA Launch Schedule," https://www.spacelaunchschedule.com/category/usa/ (accessed August 15, 2022).

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seven spaceborne (dormant) spares, the system has enough redundancy and resiliency to handle losses associated with normal (not combat-related) space operations.

The current and growing DOD demands for imagery and collection are another thing entirely. The shortfall is projected to be so great that the Departments of the Air Force and Army, the National Reconnaissance Office, and other agencies have invested in and are employing the services of commercial organizations to provide collection and imagery on demand.[78]

Over the past several years, the U.S. Army has conducted a series of exercises called Project Convergence (PC), which are designed to test the capability of DOD and commercial spaceborne systems to provide the intelligence, imagery, and communications linkages for warfighters in the service's "close fight." In PC20, Brigade Combat Teams (BCTs), Combat Aviation Brigades (CABs), and Expeditionary Signal Battalion-Enhanced (ESB-E) units were given access to 600 commercial SpaceX Starlink satellites in LEO[79] where low latency (time for signals to get to satellites and back to other users) readily enables tactical employment.[80]

The capabilities associated with defense and commercial satellites in low-Earth orbit have only grown over the years. In 2021, the Army launched three Gunsmoke-J CubeSat satellites to demonstrate advanced information collection in direct support of Army combat operations,[81] expanding the Army's inherent targeting capability.[82] Coupled with the sensors on Starlink's rapidly expanding constellation, which numbers more than 2,662 satellites,[83] these systems will enable the Army's concept for a Multi-Domain Operations (MDO)–Capable Force by 2028 and an MDO-Ready Force by 2035.[84]

The capabilities and resiliency offered by commercial systems like Starlink have been clearly demonstrated in Ukraine, where thousands of deployed Starlink Internet terminals have ensured Ukraine's internal and external connectivity with Western governments, nullifying a significant part of Russia's information campaign.[85] Starlink reportedly

TABLE 16

Satellites by Weight

Group Name	Weight	Size
Large Satellite	1,000+ kilograms	Large
Medium Satellite	500–1,000 kilograms	Medium
Mini Satellite	100–500 kilograms	Small
Micro Satellite	10–100 kilograms	Small
Nano Satellite (CubeSats)	1–10 kilograms	Small
Pico Satellite	0.1–1 kilograms	Small
Femto Satellite	<100 grams	Small

SOURCE: Table 1, "Satellites by Mass," in Chalie L. Galliand, "Study of the Small: Potential for Operational Military Use of CubeSats," 24th Annual AIAA/USU [American Institute of Aeronautics and Astronautics/Utah State University] Conference on Small Satellites, August 10, 2010, p. 1, https:// digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1199&context=smallsat (accessed August 18, 2022).

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also has the ability to provide a very accurate PNT backup for GPS, which will become increasingly important for all of the services as the competition in space intensifies.[86] Integrating LEO, Mid Earth Orbit (MEO), and GEO satellite capabilities will continue to increase network resiliency by providing multiple communications options for the warfighter.[87] The capabilities demonstrated in the PC exercise series are similar to those sought in the Air Force's Advanced Battle Management System (ABMS) and the Navy's Overmatch C2 development programs.[88]

Intelligence, Surveillance, and Reconnaissance (15 Satellites). The USSF has 15 known spaceborne systems dedicated to missile launch warning. While the SBIRS constellation is two GEO satellites short of design, its 10 satellites, coupled with the five DSP satellites, provide global coverage and generally excellent response times.

As noted, the current portfolio of reconnaissance satellites, while highly classified, meets many of the essential strategic requirements of the National Command Authority (NCA) and the Defense Department. However, Space Force capabilities fall well short of the needs of the services. The Department of the Air Force is therefore investing in and employing the services of commercial organizations to meet the on-demand collection and imagery needs of USSF customers.[89]

Space Situational Awareness (10 Satellites and 23 Terrestrial-Based Systems). The Space Force's six acknowledged SSA satellites, four other unacknowledged satellites, six dedicated and 17 collateral and contributing ground-based sensors help to maintain situational awareness of satellites and other objects in space. However, the limited number and inherent limitations of the sensors within the SBSS leave significant gaps in coverage. Those gaps are addressed by prediction, and every time a satellite maneuvers, "the process of initial discovery by a sensor, creation of an initial element set, and refinement of that element set needs to be repeated."[90]

The backbone and ISR assets within the USSF are critically important; however, the focus of the *Index of U.S. Military Strength* is primarily on assessing the classic "hard combat power" found in defensive and offensive systems.

Defensive Capabilities

Defensive systems and operations are designed to protect friendly space capabilities against kinetic anti-satellite (ASAT) weapons, high-powered lasers, laser dazzling or blinding, and high-powered microwave systems.[91]

The first challenge in defense is detecting an attack, and a host of sensors exist that can detect the launch of terrestrial-based ASAT weapons. With 14

satellites dedicated to detecting missile launches, it is possible for the USSF to determine an ASAT's trajectory, identify the targeted satellite, and alert operators in time for them to take evasive action with those systems. Unfortunately, the gaps in the SSA network highlighted earlier make the timely assessment of and response to such an attack on a specific U.S. satellite difficult.

Detecting other (non-missile) attacks presents another problem, and the Space Force has fielded a system that can deal with one part of that challenge. Operated by ground-based units, Bounty Hunter can detect an adversary's attempts to deceive, disrupt, deny, or degrade satellite communications by monitoring electromagnetic interference across multiple frequency bands. Bounty Hunter operators can locate sources of intentional and unintentional interference and minimize them.[92] This system achieved initial operational capability (IOC) in the summer of 2020 and is a significant addition to the Space Force portfolio, but it has no known capability to detect or counter lasers.

USSF satellites need a sensor package that allows them to self-detect hostile system engagement and report it to operators who are positioned to take defensive actions or that incorporates artificial intelligence (AI) that will allow the satellite to maneuver autonomously while maintaining mission capacity. Those capabilities are currently not known to exist.

Cyberattacks present a different challenge to space-based systems. Like other kinetic and non-kinetic attacks, cyber intrusions can cause service disruptions, sensor interference, or the permanent loss of satellite capabilities. Additionally, an effective cyberattack could corrupt the satellite's data stream to reliant elements or systems—or even allow an adversary to seize control of a satellite. According to the Royal Institute of International Affairs, the U.S. is well behind its peer competitors in this area and should assume that its satellite constellations have already been penetrated and compromised.[93]

In spite of current limitations, protective measures that the service can take now to safeguard its spaceborne systems can be separated into two categories of systems and actions: active and passive.

- An active defense is really offensive in nature and includes engagements to destroy, nullify, or reduce enemy systems that put U.S. and allied systems and capabilities at risk.
- Passive defense measures increase survivability through asset diversification, including the deployment of more space systems in different orbits, as well as real-time satellite maneuverability and self-protection.[94]

Shortly before the USSF became an independent service, the Air Force made clear that it wanted to build a constellation of thousands of small satellites (SmallSats) in low-Earth orbit to provide a redundant, diversified portfolio of capabilities. Over time, it has become apparent that those expanding constellations will be comprised of both military and civilian satellites.[95]

Offensive Systems

The Air Force's FY 2017 budget included $158 million to develop offensive space capabilities over a period of five years.[96] The only offensive space system of record within the USSF that can be found in open-source literature is a system called Meadowlands.

Meadowlands is a mobile, terrestrial-based, counter-communications system (CCS) that delivers effects to thwart adversary SATCOM in a given area of responsibility (AOR). The effects of Meadowlands are reversible: When the system is turned off, the communications linkages it was targeting return to their original functionality.[97]

Readiness

The Space Force was born of a congressionally mandated study that included a plan for the incremental transition of operational Air Force space assets and personnel to the new service. Throughout the plan's execution, the USSF has been deliberate in its hiring and is on a path to developing a solid cadre of personnel and a strong organizational culture.

The operations assumed by the USSF to support strategic and high-end operational-level support have proceeded uninterrupted, and readiness has remained high, but those operations were primarily supportive in nature and did not include robust, nearly real-time support to tactical units. While the service is undoubtedly moving forward on credible defensive and offensive readiness, there is little evidence that it is ready for the threat envisioned by Congress when it authorized creation of the Space Force.

Scoring the U.S. Space Force

Capacity Score: Weak

The number and types of backbone and ISR assets are sufficient to support global PNT requirements and the majority of strategic-level communications, imagery, and collection requirements of the National Command Authorities and the Department of Defense. However, the Space Force is not capable of meeting current—much less future—on-demand, operational, and tactical-level warfighter requirements.

As noted in the capability section, the gaps in the SBSS are covered by prediction, and operators of adversarial satellites can time their maneuvers to take advantage of those gaps. With the influx of SmallSats, the potential for the number of U.S. military satellites in orbit to grow from a few hundred to several thousand over the next three years is very real. (See Table 13.) If new commercial, allied, and adversary SmallSats are added to the mix, it is highly likely that the number of operational satellites in orbit will double over that same period. Although increasing numbers alone will challenge the current Space Surveillance Network, the number of unannounced orbital changes among those satellites will make it markedly more difficult to keep track of bad actors.

The U.S. had announced plans to build a second, strategically located Space Fence like the one on Kwajalein Atoll in Western Australia in 2021, but that site has yet to be funded.[98] Even if a second Space Fence does eventually materialize, the Space Force will still need more satellites that are dedicated to this mission.[99]

The service's two counterspace weapons systems (Meadowlands and Bounty Hunter) cover only a fraction of the offensive and defensive capabilities required to win a conflict in space. Other counterspace systems are probably being developed or, like cyber, already in play without public announcement. Nevertheless, the USSF's current visible capacity is not sufficient to support, fight, or weather a war with a peer competitor.

Capability Score: Weak

The current space asset modernization plan that is visible to the public follows the same incremental replacement and fielding design that has been in practice for decades. The vast majority of backbone and ISR assets have exceeded their designed life spans, and the DAF's willingness to delay and/or defer the acquisition of replacement systems remains a legacy of that department.

The capability of backbone and ISR satellites is marginal, but that is more than offset by the gaps in SSA and the apparent lack of defensive and offensive capabilities ("very weak"). The capability score is therefore "weak," the result of being scored "weak" in "Size of Modernization Program," "weak" for "Age of Equipment" and "Health of Modernization Programs," and "weak" for "Capability of Equipment."

Readiness Score: Weak

The mission sets, space assets, and personnel that transitioned to the Space Force and those that have been assigned to support the USSF from the other services have not missed an operational beat since the Space Force stood up in 2019. Throughout that period, the readiness levels have seamlessly sustained backbone and ISR support to the NCA, DOD, Combatant Commanders, and warfighters around the world.

However, there is little evidence that the USSF has improved its readiness to provide nearly real-time support to operational and tactical levels of force operations ("marginal") or that it is ready in any way to execute defensive and offensive counterspace operations to the degree envisioned by Congress when it authorized creation of the Space Force ("very weak").

Overall U.S. Space Force Score: Weak

This is an unweighted average of the USSF's capacity score of "weak," capability score of "weak," and readiness score of "weak."

U.S. Military Power: Space

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability		✓			
Readiness		✓			
OVERALL		✓			

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Navigation

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Global Positioning System (GPS) Inventory: **37** Fleet age: **12.5** Date: **1997** GPS satellites provide precise positioning, navigation, and timing (PNT) to millions of simultaneous users around the world. The current constellation of 37 satellites is comprised of Block IIR (launched from 1997-2004), IIR-M (2005-2009), IIF (2010-2016) and III/IIIF (first launch 2018) birds with steadily increasing capabilities.	5	5	**GPS III** Timeline: **2019–TBD** GPS III is the latest upgrade to the GPS platform and incorporates more robust anti-jamming capabilities. It is interoperable with other countries' Global Navigation Satellite Systems, which adds resilience to the GPS system. **PROCUREMENT** 5 14 **SPENDING** *($ millions)* $1,451 $5,568	5	5

Missile Warning

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Space Based Infrared System (SBIRS) Inventory: **10** Fleet age: **8** Date: **2006** An integrated constellation of 10 satellites, SBIRS is designed to deliver early missile warning and provide intercept cues for missile defenses. The satellites are retaskable, which means they can be moved to more optimum orbits and viewpoints as mission requirements dictate. The program was ended early due to cost, schedule, and performance issues.	5	5	**Next Generation Persistent Infrared (Next-Gen OPIR)** Timeline: **TBD** When the SBIRS program was ended early, its remaining funding was shifted to its follow-on program, the Next-Gen OPIR. This program's objective is to deliver resilient detection and tracking capability in a contested environment, given the advances in adversary rocket propulsion technology.		
Defense Support Program (DSP) Inventory: **5** Fleet age: **22** Date: **1970** These satellites were designed to detect intercontinental ballistic missile and Sea-launched ballistic missile launches against the U.S. and its allies. They can also detect space launch missions and nuclear weapons testing/detonations. Phase 3 satellites were launched from 1989 to 2007 and have long exceeded their designed lifetimes, but at least five of those satellites are still providing reliable data and are integrated with the SBIRS program.	1	4			

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Space Surveillance

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Space Based Surveillance System (SBSS) Inventory: **1** Fleet age: **12** Date: **2010** This single satellite uses multiple types of sensors to track man-made objects and debris fields in orbit.	3	3	None		

Missile Defense

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Space Tracking and Surveillance System Advanced Technology Risk Reduction (STSS-ATR) Inventory: **1** Fleet age: **13** Date: **2009** This research, development, testing, and evaluation (RDT&E) satellite was originally launched by the Missile Defense Agency to explore different capabilities and technology but was transferred to the Air Force in 2011.	3	3	None		

Space Object Tracking

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Geosynchronous Space Situational Awareness Program (GSSAP) Inventory: **6** Fleet age: **5** Date: **2014** This highly classified, six-satellite constellation can accurately track and characterize objects in orbit using electro-optical and emissions sensors. Their maneuverability allows them to conduct rendezvous and proximity operations (RPO) on space objects, giving them the potential to conduct offensive operations against other nations' assets.	5	5	None		

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Weather

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Defense Meteorological Satellite Program (DMSP) Inventory: **3** Fleet age: **18** Date: **1999** Since 1962, defense weather satellites in the DMSP have been collecting weather data and providing forecasts for U.S. military operations. This three-satellite constellation was launched between 1999 and 2009 with only a five-year life expectancy, but they have continued to provide accurate meteorological data well beyond that timeframe and are still in use today.	1	4	**Weather System Follow-on Microwave Satellite (WSF-M)** Timeline: **TBD** This next-generation weather satellite will be capable of mapping both terrestrial and space weather and is scheduled to be fielded in 2023. It covers three gaps in DOD's current weather monitoring capability: ocean surface vector winds, tropical cyclone intensity, and "energetic charged particles" in low earth orbit.		

Communications

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Milstar Inventory: **5** Fleet age: **23.5** Date: **1994** Milstar is a satellite communications system designed in the 1980s to provide the National Command Authorities with global communications that were assured, were survivable, and carried low probability of interception or detection. Designed to overcome nuclear effects and enemy jamming, this five satellite constellation was considered the most robust and reliable DOD SATCOM system at the time of fielding.	1	3	None		
Advanced Extremely High Frequency System (AEHF) Inventory: **6** Fleet age: **7** Date: **2010** The AEHF constellation is the follow-on to Milstar. Each of the six satellites provides DOD with more capacity than the entire Milstar constellation with five times the Milstar data rates. The system offers secure, jam-resistant communications and command and control for military ground, sea, and air assets located anywhere in the world.	5	5			

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Communications (Cont.)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Defense Satellite Communications System (DSCS) Inventory: **7** Fleet age: **29.5** Date: **1982** This system of seven satellites provides nuclear-hardened, global communications with anti-jamming capabilities to the Defense Department, State Department, and National Command Authorities.	1	2	None		
Wideband Global SATCOM (WGS) Inventory: **10** Fleet age: **9** Date: **2007** WGS, formerly known as the Wideband Gapfiller Satellite, is a joint-service program funded by the U.S. Air Force and U.S. Army along with international partners Australia and Canada. The 10-satellite constellation uses direct broadcast satellite technology to provide command and control for U.S. and allied forces.	4	5			
Fleet Satellite Communications System (FLTSATCOM) Inventory: **6** Fleet age: **38.5** Date: **1978** This constellation of six operational satellites is used by the Navy, the Air Force, and the presidential command network. It was transferred from the Navy to the Space Force in June 2022.	1	3			
Ultra-High Frequency Follow-On (UFO) Inventory: **10** Fleet age: **24** Date: **1993** The 10-satellite UFO constellation was designed to replace FLTSATCOM and provides communications for tactical users including aircraft, ships, submarines, and ground forces. The Navy transferred this system to the Space Force in June 2022.	1	3			

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Communications (Cont.)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Mobile User Objective System (MUOS) Inventory: **5** Fleet age: **8** Date: **2012** This next-generation narrowband tactical satellite communications system is designed for tactical users, significantly improving ground communications even for troops in highly remote locations or buildings with no other satellite access. The Navy transferred this five-satellite constellation to the Space Force in June 2022.	4	5	None		

NOTES: See Methodology for descriptions of scores. Fleet age is the average between the last year of procurement and the first year of initial operational capability. The date is when the platform achieved initial operational capability. The timeline is from the start of the platform's program to its budgetary conclusion. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E).

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