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RUSSIA

> "Only with support from space will it be possible for the Armed Forces to reach maximum effectiveness...The Russian President has repeatedly stressed that our army and navy must not only meet the requirements of today, but to [sic] be prepared for tomorrow's means of conducting armed struggle. The solution of this problem doubtlessly depends directly on the availability of a modern orbital constellation of military satellites."
>
> –Russian Defense Minister Sergey Shoygu, March 6, 2018[143]

Russia views its space program as a longstanding example of its leadership on the international stage. Russia is a pioneer of space, dating back to its launch of the first satellite, Sputnik-1, and placing the first person into orbit around Earth, Yuri Gagarin. The International Space Station's reliance on Russian launch vehicles to send astronauts to and from the station reinforces Moscow's perspective that it remains a global leader in space. In the years following the end of the Cold War, a combination of budgetary constraints and technological setbacks caused a decay of Russian space capabilities including space-based remote sensing and satellite navigation.[144]

Russia's space program is robust but more narrowly focused and its budget more limited than China's because of competing priorities with broader military modernization efforts.[145] Nonetheless, over the last two decades, Moscow has been developing a suite of counterspace weapons capabilities, including EW to deny, degrade, and disrupt communications and navigation and DEW to deny the use of space-based imagery.[146,147] Russia is probably also building a ground-based missile capable of destroying satellites in orbit.[148,149] Similar to China, Russia supports space arms control agreements to prevent weaponization of space, even as it views space as a warfighting domain.[150]

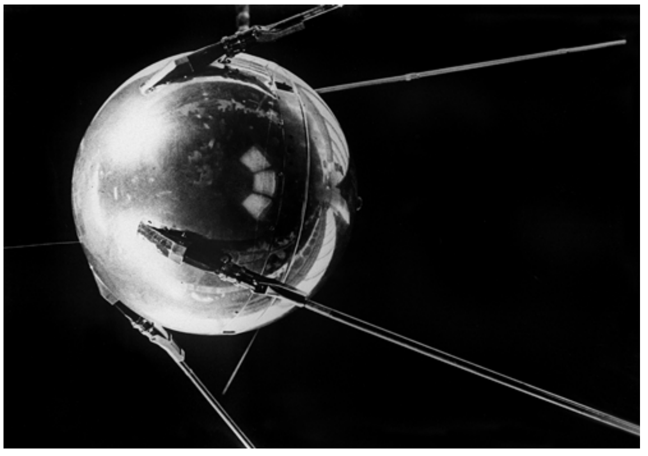


Image Source: AFP

Sputnik-1, the world's first manmade satellite, launched in 1957 and was part of the competition between the United States and Soviet Union for dominance in space.

Strategy, Doctrine, and Intent

Russian military doctrine and authoritative writings clearly articulate that Russia views space as a warfighting domain and that achieving supremacy in space will be a decisive factor in winning future conflicts.[151,152,153,154] Russian military thinkers believe the importance of space will continue to expand because of the growing role of precision weapons and satellite-supported information networks in all types of conflict.[155,156] Meanwhile, Russia regularly expresses concern over the weaponization of space and is pursuing legal, binding space arms control agreements to curb what it sees as U.S. weaponization of outer space.[157,158,159]

As Russia continues to modernize its military, it will increasingly incorporate space-provided services across its forces. Russia possesses a robust space program with a strong foundation of technical knowledge and expertise fostered by over 60 years of experience in space. However, Moscow wants to avoid becoming overly reliant on space to carry out its national defense mission.[160,161,162]

Moscow views space as a key enabler of U.S. precision strike and military force projection capabilities. When paired with U.S. missile defense systems, Russia believes U.S. space-enabled, conventional precision strike capabilities undermine strategic stability.[163,164] At the same time, Russia views America's perceived dependence on space as the "Achilles heel" of U.S. military power, which can be exploited to achieve Russian conflict objectives.[165] Russia is therefore pursuing counterspace systems to neutralize or deny U.S. space-based services, both military and commercial, as a means of offsetting a perceived U.S. military advantage and is developing an array of weapons designed to interfere with or destroy an adversary's satellites.[166,167]

Russian counterspace doctrine involves employing ground, air, and space-based systems to target an adversary's satellites, with attacks ranging from temporary jamming or sensor blinding to destruction of enemy spacecraft and supporting infrastructure.[168,169,170,171] Moscow believes developing and fielding counterspace capabilities will deter aggression by adversaries reliant upon space.[172] If deterrence fails, Russia believes its counterspace forces will offer its military leaders the ability to control escalation of a conflict through selective targeting of adversary space systems.[173,174]

Key Space and Counterspace Organizations

In 2015, Moscow reorganized its military and civilian space programs. Russia created the Aerospace Forces by merging the former Air Force and Aerospace Defense Troops. This new force includes Russia's space forces, who have the mission to conduct space launches and maintain the ballistic missile early warning system, the satellite control network, and the space surveillance network.[175,176,177] The defense minister stated the change was "prompted by a shift in the center of gravity... towards the aerospace sphere" and as a counter to the U.S. Prompt Global Strike doctrine.[178,179]

Image Source: Russia Ministry of Defense/Creative Commons 4.0 Copyright

The Russian Space Force Commander, Gen-Col Aleksandr Golovko, oversaw the launch of a GLONASS-M navigation satellite in November 2018.[180] Gen-Col Golovko is the first commander of the Space Forces, which are subordinate to the Aerospace Forces.[181]

Russia's reorganization of its civil space program was designed to improve upon inefficiencies across the sector, and now Russia's space industry is almost exclusively owned by the Russian state.[182] State corporation Roscosmos is the executive body responsible for overall management of the space industry and carries out Russia's civil space program. The space industry is primarily composed of 75 design bureaus, enterprises, and companies that carry out research, design, and production of its space technologies, satellites, and space launch vehicles for both civil and military purposes.[183,184]

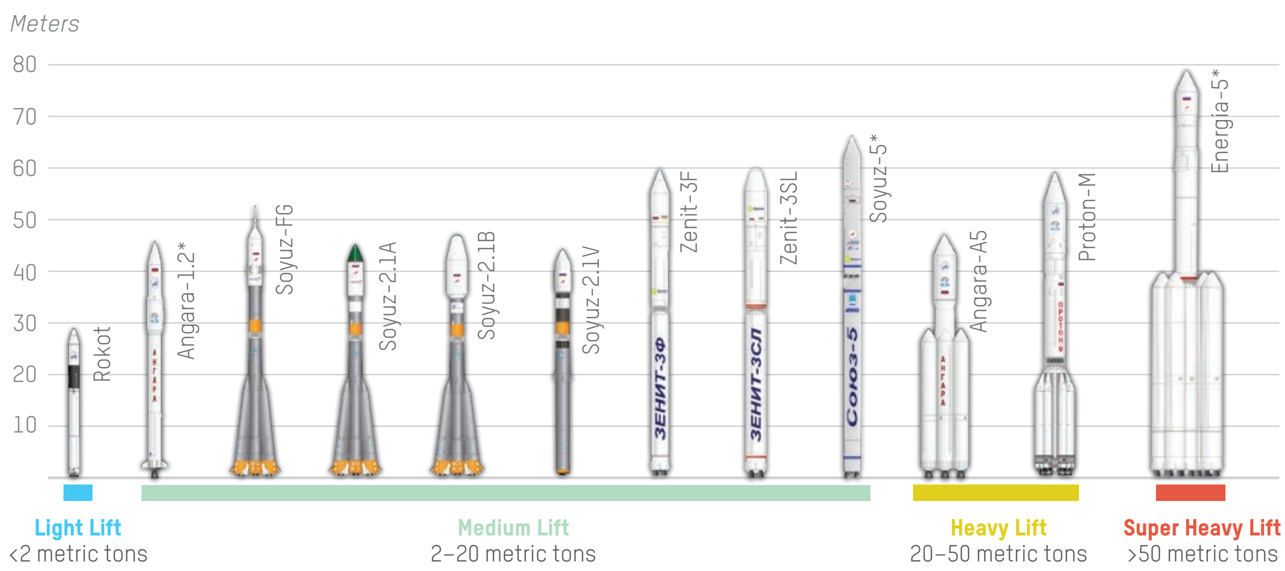
Space and Counter-space Capabilities

Space Launch Capabilities

Russia is updating and improving its space launch capabilities to enhance reliability, alleviate environmental concerns, increase manufacturing efficiencies, and support future human spaceflight and deep-space exploration missions.[185,186]

Russia's updates to its medium- and heavy-lift launch fleets include modular SLVs, which allow Russia to tailor SLVs to the specific configuration required for each customer. Unlike China, Russia has not focused on new light-lift SLV designs, usually choosing to launch small satellites on multi-payload launches. Russia is also in the early stages of developing a super heavy-lift SLV similar to the U.S. Saturn-V or the newer Space Launch System to support proposed crewed lunar and Mars exploration missions.[187]

Russian Space Launch Vehicles



** Developmental*

Depicted payload capacity is approximate and varies depending on planned orbit.

Russia has focused on maintaining its own military and civil satellites on orbit and selling launch services commercially. Russia usually launches small satellites as multiple payloads on heavier rockets but sometimes uses the Rokot light-lift vehicle to launch smaller payloads into LEO. Russia's heavy-lift vehicles are mostly used for launching into GEO or HEO. The developmental Energia SLV, designed to boost the Russian space shuttle into orbit, was discontinued in the 1980s and revived in 2016 to support proposed lunar missions.

Visualization: DIA, D3 Design • 1811-19985

Russian Space Launch Sites and Key Satellite Control Centers

Russia owns three of its launch sites and leases one from Kazakhstan. The European Space Agency has also contracted Russia to conduct launches from Kourou, French Guiana. Russia's space control sites are spread across Russia to enable effective satellite C2.

Visualization: DIA, D3 Design • 1811-19970

Human Spaceflight and Space Exploration

Russia's human spaceflight program started in the late 1950s and saw its first major milestone with the launch of Yuri Gagarin aboard the Vostok-1 spacecraft in 1961. Since that historic launch, the Soviet Union and then the Russian Federation has launched the Salyut, Almaz, and Mir Space Stations. As of 2018, Russia is a major player in human spaceflight through their work with the International Space Station, which is completely reliant on Russian support to launch astronauts to the station.[188,189,190,191]

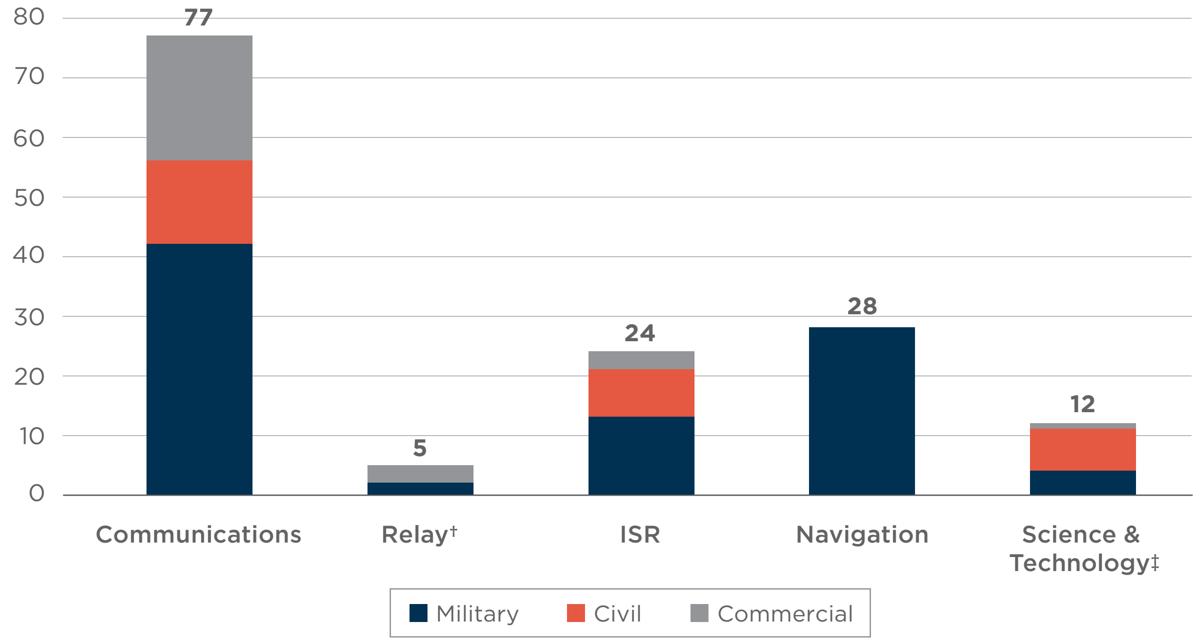
Image Source: AFP

Russia's Soyuz MS-07 carries astronauts to the International Space Station, December 2017.

ISR, Navigation, and Communications Capabilities

Russia numbers third in the world, behind the United States and China, in terms of operational satellites, with over 140 in various orbits.[192] These systems provide Russia's military with satellite communications, high-resolution imagery, navigation, ballistic missile early warning, electronic intelligence, and meteorological services.

Russian Satellites on Orbit, as of 1 May 2018[193,194,195,196]



† Relay satellites enable communication between satellites outside the reception area of a ground station.
‡ Science and technology satellites are used for scientific research or testing new space technologies.

Visualization: DIA, D3 Design • 1811-19937

Since the end of the Cold War, Russia has sought to sustain its atrophying ISR and remote sensing satellite fleet, despite funding shortfalls, economic sanctions, and technological setbacks. Though possessing fewer satellites than China, the individual capabilities of Russian ISR and remote sensing satellites can surpass China's. The Russian military owns and operates about half of those, but the military may also be able to leverage civil and commercial ISR and remote sensing satellites to supplement military-dedicated capabilities. These systems currently support ongoing military operations in Syria but can also monitor U.S. and NATO forces operating globally.[197,198]

Russia maintains a SATCOM fleet that provides resilient communications services to civil, government, and military users within its borders and worldwide. Russia continues to lag behind other worldwide providers, even though it has taken some steps toward SATCOM modernization, such as establishing partnerships with European satellite manufacturers to improve satellite reliability and capabilities.[199,200]

Russia views its Global Navigation Satellite System (GLONASS) as supporting its economic development and national security interests.[201] The constellation currently provides PNT services worldwide. Following the constellation's deterioration in the late 1990s, Russia committed to reconstituting GLONASS during the 2000s and regained full operating capability in 2011.[202] Russia now maintains its GLONASS constellation with launches as satellites become inoperative while it continues development of next-generation GLONASS satellites, promising higher accuracy.[203]

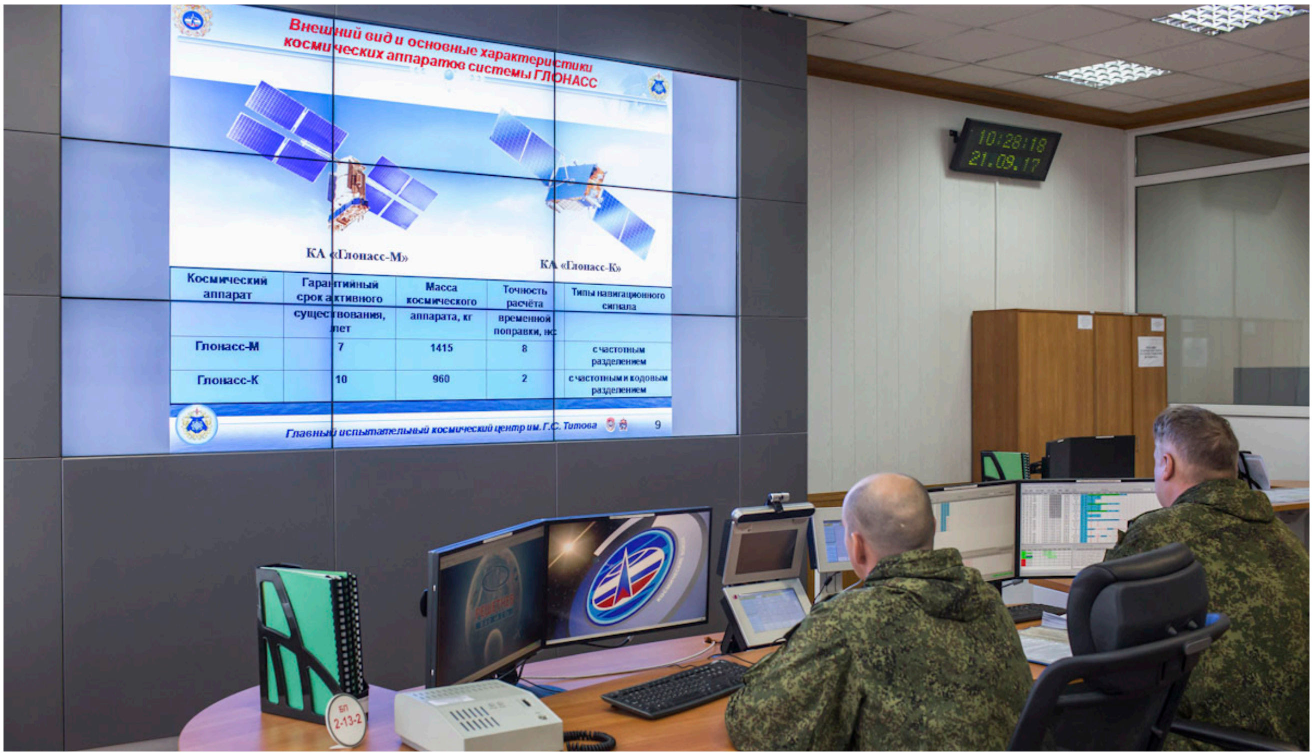


Image Source: Russia Ministry of Defense/Creative Commons 4.0 Copyright

Russian Aerospace Forces monitor GLONASS satellites at the Titov Main Test and Space Systems Control Center in Krasnoznamensk outside Moscow.[204]

Counterspace Capabilities

Space Situational Awareness. Russia's space surveillance network, composed of a variety of telescopes, radars, and other sensors, is capable of searching for, tracking, and characterizing satellites in all Earth orbits. This network allows Russia to support missions including intelligence collection, counterspace targeting, spaceflight safety, satellite anomaly resolution, and space debris monitoring. Some of these sensors also perform a ballistic missile early warning function.[205]

Electronic Warfare. The Russian military views EW as an essential tool for gaining and maintaining information superiority over its adversaries, allowing Russia to seize the operational initiative by disrupting adversary command, control, communications, and intelligence capabilities. Russia has fielded a wide range of ground-based EW systems to counter GPS, tactical communications, satellite communications, and radars.[206] Mobile jammers include radar jammers and SATCOM jammers. Russia has aspirations to develop and field a full spectrum of EW capabilities to counter Western

Russian International SSA Efforts

Russia leads the nongovernmental organization International Scientific Optical Network (ISON), which has the largest foreign network of ground-based optical space surveillance sensors. ISON can trace its existence back to 2001, and participants now include international academic and scientific organizations and government entities such as Roscosmos. The Keldysh Institute of Applied Mathematics coordinates sensor tasking and fuses information from nearly 100 ground-based optical sensors on 40 observatories spread across 16 countries.[207,208]

C4ISR and weapons guidance systems with new technology, data transfer, and capabilities for peacetime and wartime use by 2020.[209,210]

Image Source: Russia Ministry of Defense/Creative Commons 4.0 Copyright

Russia has invested heavily in developing sophisticated electronic warfare capabilities, including this Krashuka-4 jammer.

Directed Energy Weapons. Russia likely is pursuing laser weapons to disrupt, degrade, or damage satellites and their sensors. Prior to July 2018, Russia began delivering a laser weapon system to the Aerospace Forces that likely is intended for an ASAT mission. In public statements, President Vladimir Putin called it a "new type of strategic weapon," and the Russian Defense Ministry asserted that it is capable of "fighting satellites in orbit."[211,212,213,214] Russia is also developing an airborne ASAT laser weapon system to use against space-based missile defense sensors.[215]

Image Source: SPUTNIK/AFP

Russian laser weapon likely intended for use against satellites, July 2018.

Cyberspace Threats. Since at least 2010, the Russian military has prioritized the development of forces and capabilities, including cyberspace operations, for what it terms "information confrontation," which is a holistic concept for ensuring information superiority. The weaponization of information is a key aspect of this strategy and is employed in times of peace, crisis, and war. Russia considers the information sphere to be strategically decisive and has taken steps to modernize its military's information attack and defense organizations and capabilities.[216]

Orbital Threats. Russia continues to research and develop sophisticated on-orbit capabilities that could serve dual-use purposes. For example, inspection and servicing satellites can be capable of closely approaching satellites to inspect and potentially fix issues causing malfunctions; this same technology could also be used to approach another country's satellite and conduct an attack that results in temporary or permanent damage.[217] In 2017, Russia deployed what it described as an "inspector satellite capable of diagnosing the technical condition of a Russian satellite from the closest possible distance"; however, its behavior is inconsistent with on-orbit inspection activities or space situational awareness capabilities.[218,219,220]

Ground-based Kinetic Energy Threats. Russia likely is developing a ground-based, mobile missile system capable of destroying space targets in LEO and ballistic missiles.[221,222] This weapon system is likely to be operational within the next several years.[223]

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OTHER SPACE CHALLENGES

Iran

Iran recognizes the strategic value of space and counterspace capabilities and will attempt to deny an adversary use of space during a conflict. Tehran has publically acknowledged it has developed capabilities to jam communications and GPS signals.[224,225,226] Tehran may also contribute to the proliferation of jamming equipment. Since 2010, Iran Electronics Industries has marketed several GPS jammers on its website.[227]

Tehran's pursuit of a national space program supports both civilian and military goals, including boosting national pride, economic development, and military modernization.[228] The Iran Space Agency and Iran Space Research Center—which are subordinate to the Ministry of Information and Communications Technology—along with the Ministry of Defense and Armed Forces Logistics oversee the country's SLV and satellite development programs. Iran is also seeking to improve its space object tracking capabilities and, in 2005, joined the Asia-Pacific Space Cooperation Organization.[229,230,231,232,233]


Image Source: AFP

Iran launched its first satellite on its Safir space launch vehicle in February 2009.[234]

Tehran states it has developed sophisticated capabilities, including SLVs and communications and remote sensing satellites, but its SLVs are only able to launch microsatellites into LEO and have proven unreliable. Nonetheless, Iran has had a few successful launches of the two-stage Safir SLV since its first attempt in 2008. It has also revealed the larger two-stage Simorgh SLV, which could serve as a test bed for developing intercontinental ballistic missile (ICBM) technologies. Because of the inherent overlap in technology between ICBMs and SLVs, Iran's development of larger, more capable SLV boosters remains a concern for a future ICBM capability. Also, these advancements could be applied to developing a basic ground-based ASAT missile, should Iran choose to do so in the future.[235,236,237,238]

North Korea

North Korea's space program is administered by a state-run civilian agency, the National Aerospace Development Administration.[239] North Korea's space launch complex on the west coast, the Sohae Satellite Launching Station and associated space tracking facilities in Pyongyang both supported satellite launch cycles in 2012 and 2016.[240,241] An older space launch site on the east coast has not been used for a launch since 2009.[242]

Similar to Iran, North Korea will try to deny an adversary use of space during a conflict. North Korea has demonstrated non-kinetic counterspace capabilities, including GPS and satellite communication jamming.[243,244,245] North Korea also has ballistic missiles and space launch vehicles that can reach orbit and could, in theory, be used to target satellites in a conflict.[246]

Although North Korea placed two satellites in orbit and has in the past articulated further space ambitions, their program enabled them to test technology used in ballistic missiles under the guise of peaceful use of space.[247,248,249] These systems provided North Korea with valuable data applicable to the development of long-range, multistage ballistic missiles.[250]

Image Source: AFP

A Taepo Dong 2/Unha-3 space launch vehicle preparing for launch, April 2012. The launch failed, but an attempt later that year was successful.[251]

OUTLOOK

Today, space has become a seamless part of many military and civilian activities. The advantages the United States holds in space capabilities will drive some nations to improve their abilities to access and operate in space. Moreover, some actors will seek counterspace capabilities that target the perceived United States and allied reliance on space, including the ability to use secure satellite communications, precision strike capabilities, and ISR assets.

China and Russia will continue to improve their space programs, including ISR, communications, space launch, and human spaceflight. Commercially, both will compete internationally to build satellites and supply space launch, navigation, and ISR services.

Beijing and Moscow will continue to see space as integral to winning modern wars. They are developing systems that pose a threat to freedom of action in space. Both will continue their efforts to enhance their space and counterspace capabilities, and better integrate them into their respective militaries.

Iran and North Korea will avail themselves of space-based services, such as ISR, communications, and navigation, to increase their capabilities in civil and military domains.[252] Both will maintain their ability to conduct EW against adversaries and theoretically could use their missile and SLV advancements to target orbiting satellites.

Globally, the space industry will continue to expand as technological and cost barriers fall and international partnerships for joint production grow. State, non-state, and commercial actors increasingly will have access to information from space.[253] The number of satellites and debris on orbit will grow concurrently, making tracking satellites, discriminating threats from non-threats, and predicting and preventing collisions a greater challenge.[254,255]

As the number of spacefaring nations grows and as some actors integrate space and counterspace capabilities into military operations, these trends will pose a challenge to U.S. space dominance and present new risks for assets on orbit.

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APPENDIX A: Implications of Debris and Orbital Collisions

Approximately 21,000 large objects—which are at least 10 cm in size—are tracked and catalogued in Earth's orbit, and only about 1,800 of them are active satellites. The remaining objects are debris, which includes derelict spacecraft, upper stages of SLVs, and remnants from explosions or collisions. The length of time debris remains in orbit depends on the altitude, ranging from a few years for objects below 600 kilometers to over a century for objects at higher orbits. The vast majority of debris harmlessly burns up in the atmosphere upon reentry.[256]

Prior to 2007, most debris was from explosions of upper stages of SLVs. Today, more than one third of all catalogued debris is from two major events: China's destruction of a defunct satellite in 2007 and the accidental collision between a U.S. communications satellite and a defunct Russian satellite in 2009.[257] Breakups, collisions, and explosions from derelict objects will continue to add to the amount of space debris on orbit.

Space debris can cause damage and destruction to satellites and spacecraft, as well as increase costs if satellite manufacturers add additional shielding and fuel to allow for more frequent avoidance maneuvers. Between 1998 and 2017, the International Space Station, which is in LEO, has maneuvered at least 25 times to avoid potential orbital collisions.[258] With an expected increase in large constellations of satellites and space debris, there is higher potential for satellite collisions, particularly in LEO.[259]

The increase in number of objects on orbit has implications for policymakers worldwide and is encouraging the development of space debris removal technology.[260] This technology is dual-use because it could be used to damage another satellite.[261]

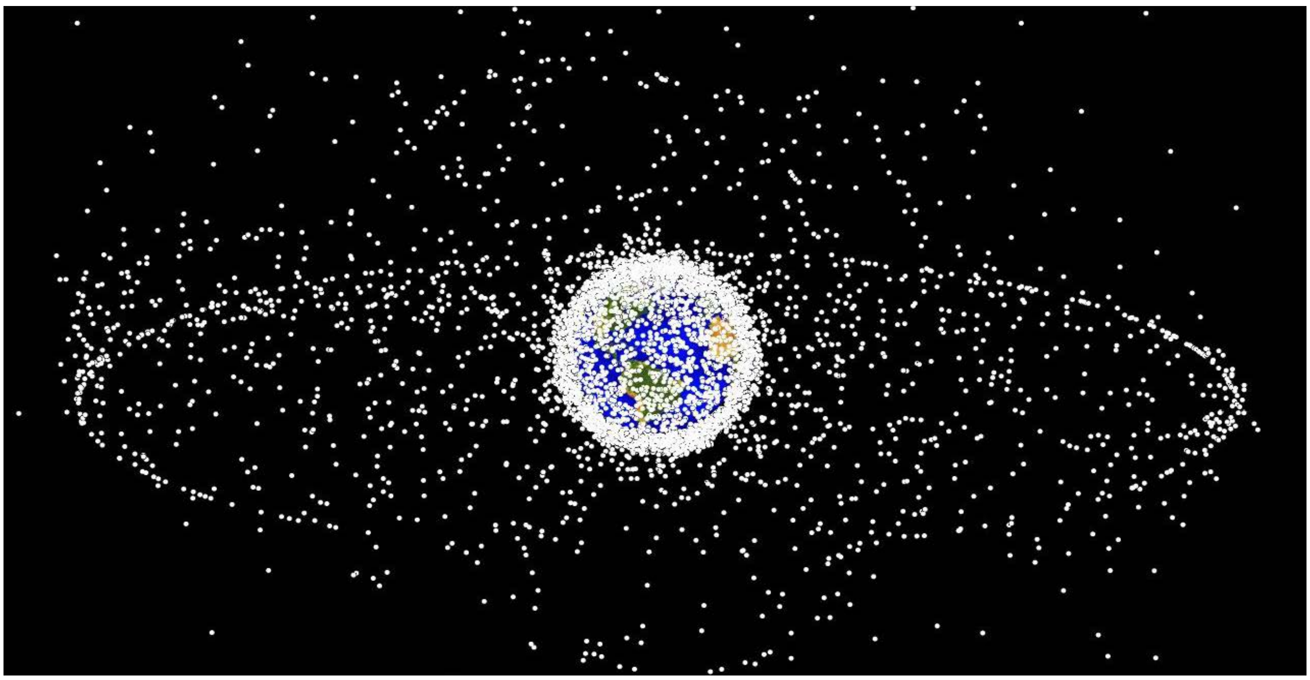
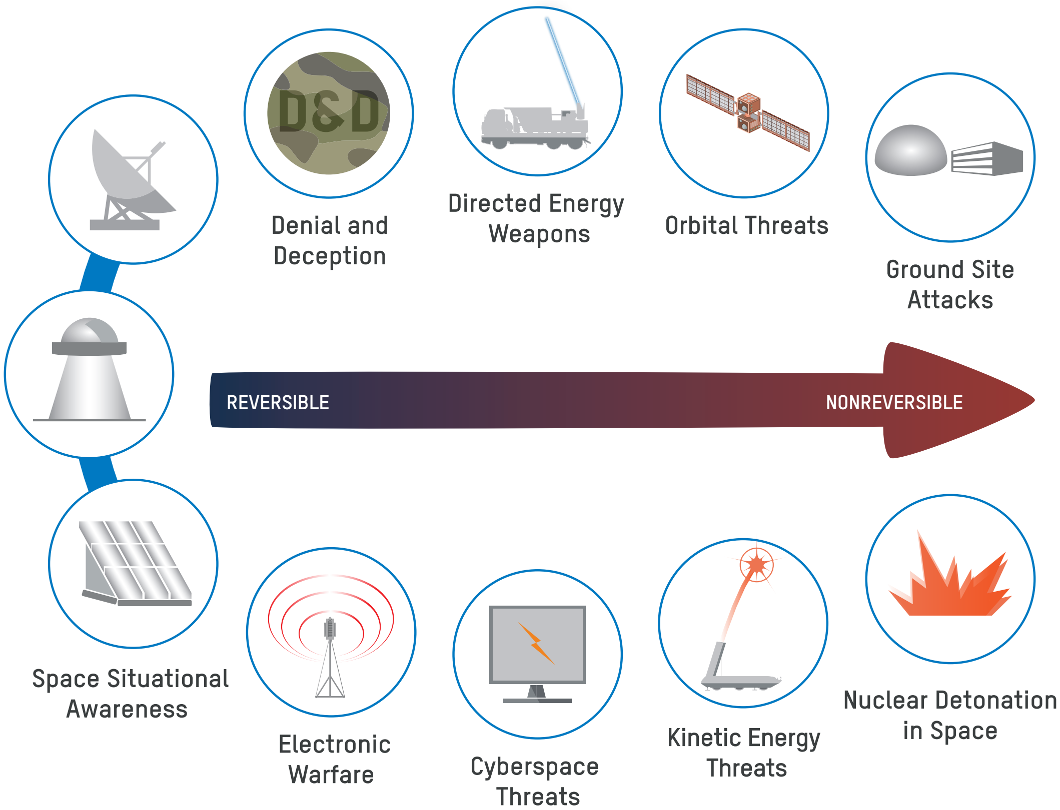


Image Source: NASA

Computer rendering of tracked large objects in Earth's orbit. Roughly 90 percent of the objects are orbital debris, not active satellites.

APPENDIX B: Counterspace Threats

Counterspace Continuum



Visualization: DIA, D3 Design • 1811-20013

The counterspace continuum represents the range of threats to space-based services, arranged from reversible to nonreversible effects. Reversible effects from denial and deception and EW are non-destructive and temporary, and the system remains capable of resuming normal operations after the incident. DEW, cyberspace threats, and orbital threats can cause temporary or permanent effects. Nonreversible effects from kinetic energy threats, physical attacks against space-related ground infrastructure, and nuclear detonation in space result in degradation or physical destruction of a space capability. In addition to counterspace capabilities already discussed, several others can be used to deny, degrade, or destroy space systems.

Denial and Deception: Actors can use knowledge of when satellites pass overhead to camouflage and conceal their activities on the ground.

Ground Site Attack: An actor could attack a ground site using physical means, disrupting an ability to communicate with and operate satellites.

Nuclear Detonation in Space: Countries that can launch a nuclear weapon with a long range rocket, such as an ICBM or SLV, likely are capable of conducting a high-altitude nuclear detonation. Both the United States and Soviet Union detonated nuclear weapons above the atmosphere in the early 1960s.[262]

APPENDIX C: Glossary of Acronyms

APOSOS	Asia-Pacific Ground-Based Optical Space Object Observation System
ASAT	Anti-satellite
C2	Command and control
C4ISR	Command, control, communications, computers, intelligence, surveillance, and reconnaissance
CNSA	China National Space Administration
DEW	Directed energy weapon
EW	Electronic warfare
GEO	Geosynchronous Earth orbit
GLONASS	Global Navigation Satellite System
GPS	Global Positioning System
HEO	Highly elliptical orbit
ICBM	Intercontinental ballistic missile
ISR	Intelligence, surveillance, and reconnaissance
KZ	Kuaizhou space launch vehicle
LEO	Low Earth orbit
LM	Long March space launch vehicle
MEO	Medium Earth orbit
PLA	People's Liberation Army
PNT	Position, navigation, and timing
SAR	Synthetic aperture radar
SASTIND	China's State Administration for Science, Technology, and Industry for National Defense
SATCOM	Satellite communications
SLV	Space launch vehicle
SSA	Space situational awareness
SSF	Strategic Support Force

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