



Updated January 27, 2020

Challenges to the United States in Space

Preserving key U.S. national security and economic interests is widely seen to depend on assured access and widespread use of space-based systems. Satellites are as essential to military and intelligence operations as fighters, warships, and combat vehicles. Major portions of the global economy rely on space systems; they facilitate the entire global financial system, stock markets, communications, agriculture, and transportation, as well as other commercial and civil activities. A June 2015 Department of Homeland Security report estimated \$1.6 trillion of annual U.S. business revenues depend on satellites. Space systems are also a permanent and seamless component in the nation's critical infrastructure, as vital as the electrical grid or the highway system.

Space, however, is no longer the exclusive domain of great powers, nor does it remain a sanctuary for science and exploration, free from conflict. In fact, U.S. officials and others identify space as a warfighting domain. Adversaries are aware of U.S. space superiority and understand the critical reliance on space systems to achieve U.S. national interests. Many military and industry analysts believe it prudent to plan for a future in which space is increasingly competitive, congested, and contested.

Competitive

Nations with comprehensive space programs possess distinct military, economic, and scientific advantages, but complexity, expense, and barriers to entry into space have allowed only a few space-faring nations to develop substantial space capabilities.

The rise of a robust global commercial space sector is rapidly altering the picture. Global revenue from space-based services annually exceeds \$300 billion, with more than two-thirds in the commercial sector. Well over \$100 billion in annual revenues arises from commercial space data services (mostly direct-to-home television). Over \$100 billion derives from commercial space equipment manufacturing. Finally, governments spend about \$80 billion per year on space programs, with the U.S. government spending roughly 60% of that \$80 billion.

Most space technologies have become dual-use, and commercial space revenues now dwarf investments by governments. This creates a dilemma. Governments regulate their space industries for strategic reasons, but more and more, nations also compete in the far-less regulated commercial space market. Eleven nations now have the space industrial capacity to develop, manufacture, launch, and operate their own space systems. More than 50 nations have purchased and operate satellites and have partial elements of a space industrial base. U.S., European, Russian, and Japanese firms still dominate, but India and China possess comprehensive and rapidly growing space industries. China is especially aggressive in capturing space

services market share in developing nations. Nations as diverse as South Korea and the United Arab Emirates are pursuing commercial space industries.

Although the global space economy has grown steadily over the past decade, the market is finite. At the same time, analysts note that the competitiveness of a nation's commercial space industry has a relationship to its ability to field affordable national security space systems. Most observers believe that maintaining a healthy U.S. space industry over the long term could require a better balance between viewing the space industry as a strategic military asset and allowing its firms to compete in the expanding global commercial space market.

A key focus area is the U.S. national security space launch (NSSL) market. Since 2006, a joint Boeing-Lockheed Martin venture, United Launch Alliance (ULA) under an Air Force contract, provided NSS missions with a number of certified launchers, the Atlas and Delta rockets. Space Exploration Technologies (SpaceX) entered the market in 2015, gaining certification to compete for NSS launches with its Falcon-9 launcher while lowering launch costs. SpaceX developed a more capable launch vehicle in the Falcon Heavy, which DOD certified in June 2018 and later awarded NSS missions under Phase 1A of the NSSL program. ULA, Northrop Grumman, SpaceX, and Blue Origin have all submitted bids for phase two of the NSSL program, with each company proposing their rocket designs: Vulcan, Omega, Falcon, and New Glenn, respectively.

Many observers believe that market dynamics have the potential to reduce prices, but they also require monitoring to ensure uninterrupted strategic access to certified U.S. launchers. The existing Atlas and Delta inventory and the Falcon-9 and Falcon Heavy are expected to provide sufficient certified launchers to meet national security requirements for the next few years as markets settle. However, developing new rockets remains challenging, and timelines and certifications may not go as planned. This is especially true in light of broader global market pressures facing U.S. launch companies.

Worldwide, the number of launch contracts available for competition averages just 20-25 per year. Arianespace in Europe has historically dominated this market, followed by Russia. China and India are taking market share as well. Launch supply may soon outpace global demand. The U.S. launch sector likely faces small margins for error in crafting future development and production plans.

Congested

There are over 2,000 active satellites in orbit. However, nearly all satellites operate in just three key orbital regimes. Low-Earth orbit (LEO) has roughly 1,300 satellites (at 300-

1,000 km altitude). Most LEO satellites perform Earth observation, weather monitoring, or mobile communication services. Geosynchronous-Earth orbit (GEO) has about 430 satellites (at roughly 36,000 km altitude). At this altitude, satellites travel at the same rate as Earth’s rotation, enabling a stationary dish on Earth to “stare” at a single point in the sky to receive a satellite signal. Thus, most GEO satellites conduct stationary telecommunications services (e.g. television broadcasting). Conversely, GEO satellites can “stare” downward at large portions of Earth, making this the preferred orbit for missions such as missile early-warning, nuclear test detection, and electronic intelligence. Between the LEO and GEO are Medium-Earth orbit (MEO) satellites. Most of the 75 MEO satellites are used for services such as GPS.

These three main orbits around Earth create restrictions similar to those created by lanes in a road. Practically speaking, there are a limited number of “slots” available for satellite operations, especially in GEO. This creates “congestion” in several ways. First is the sheer number of satellites requesting to occupy the available slots. Some prime locations for satellites are already crowded. Second is the growing number of actors in space. The 1,000-plus operational satellites are owned by more than 100 different government and commercial entities from more than 50 nations. Both the overall number of satellites and the number of players is predicted to expand.

A third congestion issue is radio frequency allocation. To maintain an active radio link to the ground, all satellites must compete for a limited number of radio frequency assignments. For U.S. satellites, the Federal Communications Commission (FCC) submits requests on behalf of satellite operators to the United Nations International Telecommunication Union (ITU), which manages global radio frequency use for satellites. These frequencies are finite, and allocation is increasingly challenging as demand grows.

Fourth, over 60 years of space activities—along with some explosive events in space including the 2007 Chinese antisatellite (ASAT) test, the 2009 Iridium-Cosmos satellite collision, and India’s ASAT test in 2019—have left large quantities of uncontrolled debris in these orbital “lanes.” This includes tens of thousands of trackable items (softball size or bigger) and many millions (170 million according to NASA) of smaller objects, any of which may disable or destroy a satellite. Orbital collision prediction and avoidance capability is limited, but improving. The U.S. has the greatest national capability in both debris tracking and collision warning, which is carried out by the Combined Space Operations Center (CSPOC) at Vandenberg AFB, CA. CSPOC has a growing number of data-sharing agreements with allies and commercial companies. In 2014, the Air Force began to develop a “Space Fence” system designed to improve tracking of orbital debris and satellites.

Contested

Most defense experts consider space to be the ultimate military high ground, with particular importance to U.S. national security operations. Adversaries have studied warfighting concepts and focused on space systems as a

particular U.S. vulnerability. Some nations, particularly Russia and China, are pursuing nondestructive and destructive counterspace weapons capabilities, such as jammers, lasers, kinetic-kill or anti-satellite (ASAT) systems, and cyber-attack capabilities. U.S. satellites no longer enjoy sanctuary in space, and U.S. military space superiority can no longer be taken for granted. The Trump Administration and senior government officials openly declare space to be a warfighting domain.

A major development in this regard is the National Space Defense Center (NSDC) at Schriever AFB, CO. The NSDC is a joint and interagency collaborative effort between the Department of Defense, the Intelligence Community, and commercial industry to research U.S. space vulnerabilities and develop tactics and doctrine to deal with potential attacks on space systems.

Against this backdrop of rising challenges, most experts view the diplomatic and legal frameworks to govern space as antiquated and inadequate. Four agreements form the basis of space law, and all were created in the early space age when space was considered a sanctuary, few nations had access to space, the Cold War dynamics defined the view of space, and commercial space endeavors were limited. Today’s realities are different. Experts agree that the stakes are far higher, more competitors are vying for advantage, and capabilities to disrupt satellites are proliferating. Some believed creating a separate service for space would help defend and protect U.S. space systems.

Space Force

On December 20, 2019, the U.S. Space Force (USSF) became the sixth branch of the Armed Forces—established within the Department of the Air Force after the enactment of the National Defense Authorization Act (NDAA) for FY2020. The mission of the Space Force is to organize, train, and equip space forces in order to protect U.S. and allied interests in space. The USSF is responsible for acquiring military space systems to provide space capabilities to the joint force. Similarly, in 2019, the DOD reestablished the U.S. Space Command (USSPACECOM), the 11th unified combatant command, formed to deter aggression and conflict, while defending U.S. and allied freedom of action. USSPACECOM is responsible for delivering space combat power to the joint force.

Space is now a more competitive, congested, and contested domain. Experts agree that Congress, other U.S. policymakers, and senior military leaders attempting to maintain the historic U.S. advantages in space face a host of challenges. Regardless of procurement, acquisition, and access challenges, broad congressional support for maintaining U.S. space dominance was critical to the establishment of the U.S. Space Force in late December 2019 and will continue to be important to monitoring its progress, through both legislation and oversight.

Stephen M. McCall, smccall@crs.loc.gov, 7-9760

IF10337