Congressional Research Service
Informing the legislative debate since 1914

IN FOCUS

Updated March 20, 2018

Challenges to the United States in Space

Preserving key U.S. national security and economic interests depends on the continued 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 now rely on space systems; they facilitate modern banking, communications, agriculture, transportation, as well as a host of other commercial and civil activities. A June 2015 Department of Homeland Security report estimated $1.6 trillion of annual U.S. business revenues heavily depend on satellites. Space systems are now a permanent and seamless component in the nation's critical infrastructure, often seen as essential as the electrical grid or the highway system. In fact, the entire global financial system depends on GPS, for instance.

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 are increasingly referring to 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 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 mean that still only a few nations have comprehensive space capabilities.

The rise of a robust global commercial space sector is rapidly altering the picture. Direct spending 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 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 major implications on 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 finding 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 launch market. Since the early 2000s, a joint Boeing Lockheed venture, United Launch Alliance (ULA), provided the Air Force with a number of certified launchers, the Atlas and Delta rockets. A new competitor, SpaceX, entered that market, gaining certification for its Falcon-9 launcher while lowering launch costs. Although the Falcon-9 cannot launch the heaviest national security payloads, SpaceX recently test launched the Falcon Heavy, which is designed to carry such payloads; its certification timeline is unknown. In response, ULA is building the new Vulcan launcher, hoping that a modern design achieves performance at a cost competitive with SpaceX.

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 are expected to provide sufficient certified launchers to meet national security requirements for the next few years as market dynamics 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 outstrip global demand. Estimates predict a dip in U.S. government launch demand coincident with SpaceX and ULA fielding their new launchers. The U.S. launch sector likely faces small margins for error in crafting future development and production plans.

Congested

There are over 1,000 active satellites in orbit. However, nearly all satellites operate in just three key orbital regimes.

Low-Earth orbit (LEO) has roughly 500 satellites (at 300-1,000 km altitude). Most LEO satellites perform Earth observation, weather monitoring, or mobile communication. 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). In reverse, 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 classes of orbits around Earth create restrictions similar to those created by lanes in a road. Practically speaking, there is a limited number of "slots" available for satellite operations, especially in GEO and LEO. This creates "congestion" in several ways. First is the sheer number of satellites for 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. A United Nations office, the International Telecommunication Union (ITU), manages radio frequency spectrum allocation for satellites, which is increasingly challenging as demand grows.

Fourth, nearly 60 years of space activities—along with some recent explosive events in space especially the 2007 Chinese antisatellite (ASAT) test and the 2009 Iridium-Cosmos satellite collision—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 hundreds of thousands 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 Joint Space Operations Center (JSpOC) at Vandenberg AFB, CA. JSpOC 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. It is scheduled to become operational in 2019.

Contested

Most 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 superiority there can no longer be taken for granted. Senior Pentagon officials now 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 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.

Many in Congress, as well as President Trump and others, have called for the creation of a new "Space Corps" or Space Force, separate from the Air Force, with the mission to more aggressively finds ways to defend and protect U.S. space systems. Others, including the Air Force, the head of U.S. Strategic Command, and many in the Senate have argued against developing a separate service from the Air Force at this juncture. Instead, they argue the Air Force should be given more time and resources to address this growing challenge.

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.

According to the intelligence community in 2018, "Russia and China continue to publicly and diplomatically promote international agreements on the nonweaponization of space and 'no first placement' of weapons in space. However, many classes of weapons would not be addressed by such proposals, allowing them to continue their pursuit of space warfare capabilities while publicly maintaining that space must be a peaceful domain."

Space has become 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.

Steven A. Hildreth, Specialist in U.S. and Foreign National Security Programs

IF10337

Disclaimer