National Security and the Commercial Space Sector

Initial Analysis and Evaluation of Options for Improving Commercial Access to Space

A Report of the CSIS Defense-Industrial Initiatives Group

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The project directors and authors are solely responsible for the contents and judgments in this report.

Overview:

In this DRAFT report, the Center for Strategic and International Studies (CSIS) examines the relationship between U.S. national security and the commercial space sector, with specific focus on the current state of the space launch industry and launch market. Building on a CSIS annotated briefing released in 2008, entitled *Health of the U.S. Space Industrial Base and the Impact of Export Controls*, this report describes the importance of the commercial space sector to U.S. national security, catalogues several principal concerns regarding commercial access to space, and provides a framework for analyzing options to improve access to commercial launch services. The report is a vehicle for further discussion of two key issues: the relationship between the commercial space sector and national security, and the ways in which U.S. policymakers might better manage the nexus between them.

Introduction:

Over the past decade, CSIS has consistently reported on concerns about the state of the space industry. During that same period, the United States has experienced an ever-increasing reliance on space in the daily lives of its citizens and, significantly, in national security. This report assesses the interrelationship between the commercial space sector and national security. Understanding the current state of the commercial space sector is integral to identifying and evaluating national security concerns and to developing options for improvement.

The study is divided into five parts. Part I discusses the relevance of the commercial space sector to national security. This first section addresses the question of "why should policymakers care?" often asked by those who study, write, and implement public policy. During an interview with CSIS, one senior commercial satellite company official stated, "Our key concern is how to put capacity on orbit." In Part I, the report first evaluates whether this concern should also be a U.S. national security priority.

Part II describes the current state of the commercial space launch market—the federal policies and directives governing space launch, international and domestic capacity, and expected global demand. This section validates the concerns voiced by commercial industry and others with regard to commercial access to space and "getting satellites on orbit."

Part III outlines a series of options that can improve commercial access to space with a concomitant benefit to U.S. national security interests. These options represent broad policy approaches available to decisionmakers and are based on discussions with experts interviewed by CSIS as well as future policies, directives, and actions currently under consideration by the Administration.

Part IV defines a set of criteria by which to evaluate the options outlined in Part III.

Part V presents the next steps of the CSIS analysis. This section calls for readers to comment and provide advice on the report's option sets and evaluation criteria. CSIS will distill and integrate the public comments received and produce a final report that will examine the finalized option sets using the evaluation criteria.

This examination of issues demonstrates the critical nexus between the commercial space sector and national security, and the need to defend the nation. The analysis asks vital questions about

the best way forward for both the public and private sectors, pointing the way to possible solutions which meet the goals and objectives of both.

Methodology:

This DRAFT report builds on a CSIS annotated briefing released in 2008, entitled *Health of the U.S. Space Industrial Base and the Impact of Export Controls*. For this assessment, CSIS updated the 2008 analysis and evaluation effort, in part to help inform and support policymakers in the new Administration.

CSIS expects that public release of the report covering concerns, option sets, and evaluation criteria will spur comment and additional input from interested parties. CSIS then will use this input as it finalizes the report, set for release approximately 60 days after release of the draft.

A substantial amount of information for this analysis and evaluation was collected through extensive interviews with key policymakers and leading experts in government, industry (both U.S. and foreign), and academia. To encourage interviewees to speak freely, all interviews were conducted on an off-the-record, not-for-attribution basis. During the past four months, CSIS averaged almost one interview or group interview per day, for a total of nearly 80 interview sessions to date. Interviews will continue during preparation of the final report.

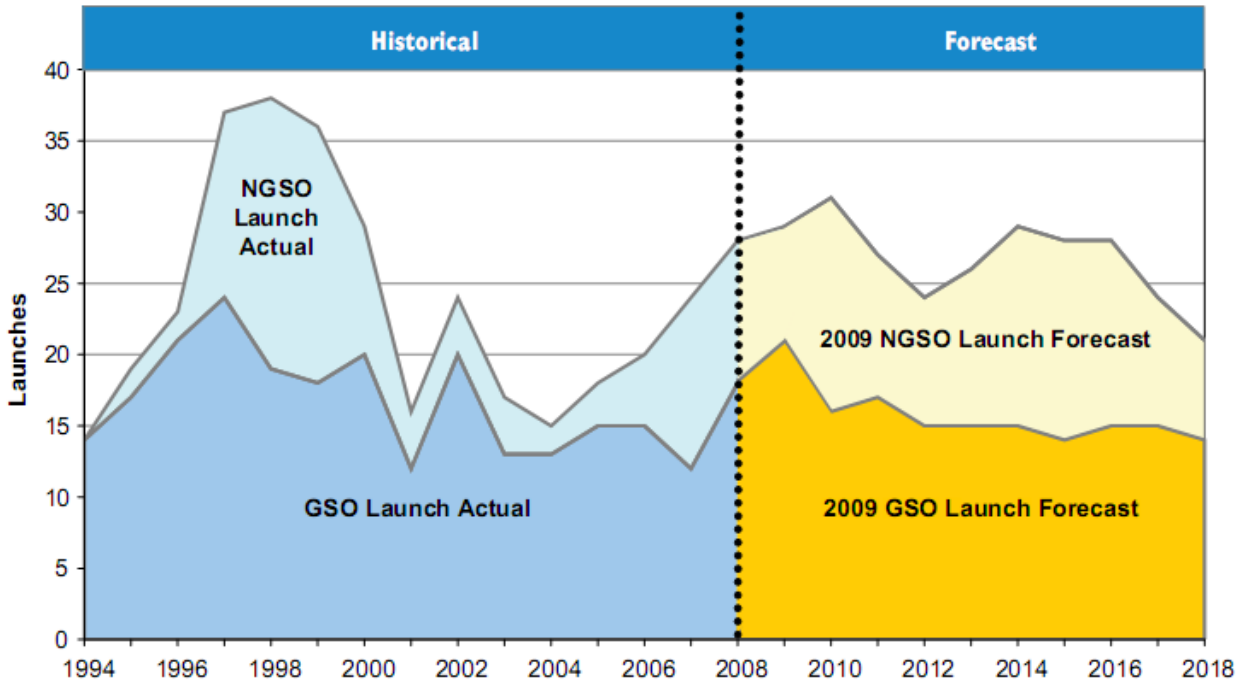
CSIS researchers interacted with individuals involved in many of the dozens of space launch studies conducted within and for the U.S. government that are ongoing or have been recently completed.[1] CSIS also reviewed extensive secondary data from organizations including Futron, New Skies, the Federal Aviation Administration (FAA), U.S. Department of Commerce (DoC), and the Department of Defense (DoD). The concerns, option sets and evaluation criteria included in this report were all informed by both these primary and secondary sources. The representations here are entirely the product of the project directors and the authors, and they are solely responsible for any factual or analytical errors that may be contained herein.

This study focuses on launch services for medium to heavy payloads, which are the most challenging to launch into geosynchronous orbit (GSO) and which account for the majority of the launch market (see Figure A).[2] The U.S. launch industry currently provides two heavy/medium launch vehicles, the Atlas V and the Delta IV. CSIS recognizes that there is a market in the smaller class of launch vehicles and providers to non geosynchronous orbit (NGSO), including those promoted by individual states such as Virginia, New Mexico, and Florida, but these remained largely outside the immediate scope of this effort. The potential effect of the smaller classes of launch vehicles, providers, and payloads on both the national security and commercial space sectors is great, and deserving of its own study. In the category of medium to heavy geosynchronous launch vehicles, providers, and payloads, the connectivity and concerns between the commercial and national security space sectors are more immediate.

[1] CSIS was presented a listing of 22 specific reports, but other interviewees cited between 17 and 29 ongoing or recently completed efforts. No interviewee was able to reference all 29.

[2] Office of Commercial Space Transportation, Federal Aviation Administration, *2009 Commercial Space Transportation Forecasts,* May 2009, http://www.faa.gov/about/office_org/headquarters_offices/ast/media/NGSO%20GSO%20Forecast%20June%203%202009%20lowres.pdf.

Figure A: Federal Aviation Administration GSO and NGSO historical launches and launch forecasts, 1994-2018



Source: Federal Aviation Administration, 2009

PART I. "Why should policymakers care about commercial access to space?":

Decisionmakers often ask those advocating for a particular cause for an answer to the critical question, "Why should I care?" Thus, before addressing the concerns of the commercial space sector's access to space, CSIS first examined the extent to which commercial access should be a concern of U.S. policymakers. Based on its investigations, CSIS has concluded that decisionmakers should care for two fundamental reasons. First, space assets provide capabilities that are critical to U.S. national security, and commercial space assets account for many of these capabilities. In short, commercial space assets are critical to U.S. security and, as outlined below, U.S. policy should address assured access to space for key commercial payloads. Second, CSIS interviews revealed widespread concerns that threaten or impede the commercial sector's access to space (section D). While not every interviewee recognized all the concerns listed, few saw no cause for apprehension at all. The issues discussed in this report are important to the space policy and acquisition communities in the U.S. government because they illuminate a vital link between national security and the commercial space sector and a consensus that commercial access to space launch is problematic.

(A) U.S. national policy requires assured access to space for national security assets, and this requirement has been U.S. policy for decades[3]

The importance of space to national security has become increasingly self-evident to U.S. policymakers and warfighters. The 2008 CSIS space study noted accurately that this importance is in no danger of diminishing.

Eight principles formed the basis for the findings and recommendations in the 2008 report and remain valid today:

(A.1) Space is critically important to U.S. national security. From command and control to communications and intelligence gathering to weapons targeting, space systems today are a key element of U.S. national security. Space systems are increasingly important for monitoring potential threats, managing military forces, and carrying out combat operations.[4]

(A.2) Space is an essential dimension of the U.S. economy. Many space technologies have reached such a level of maturity that some of their applications, such as telecommunications, automatic teller machines (ATMs), meteorology, navigation, stock market data, and transport control, are now an integral part of the daily lives of millions of U.S. citizens.

(A.3) Global leadership in space for the United States is important. It provides decisionmakers with critical intelligence, warfighters with a technological advantage on the battlefield, and citizens with services upon which they have come to depend. Furthermore, leadership in space contributes to U.S. soft power and prestige on the international stage.

(A.4) Sustaining U.S. technological superiority in space is a U.S. national security interest. It is impossible to imagine achieving this superiority while relying primarily on foreign capabilities. Given the importance of space assets to national security, it is imperative that U.S. technical superiority in space be "home grown."

(A.5) All of the segments of the U.S. space community are highly interdependent. As demonstrated in Figure 1.1, the defense, intelligence, civil, and commercial sectors of space overlap in many critical areas. This means that damage to any one of these sectors reverberates through all the others.

(A.6) A strong space industrial base is important. While the Cold War era was characterized by mostly military activity in space, the post-Cold War era has seen a surge in the private sector's involvement in space activities. Today, when space-based capabilities are increasingly important for national security and the economy,

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[3] A 2006 article by Gen. Thomas Moorman in *High Frontier* stated that the term 'assured access to space' was coined in 1983, but traces its roots to the earliest days of the Air Force's involvement in space. See: General Thomas S. Moorman, Jr., USAF (ret.), "Framing the Assured Access Debate: A Brief History of Air Force Space Launch," *High Frontier* 3, iss. 1, (November 2006).

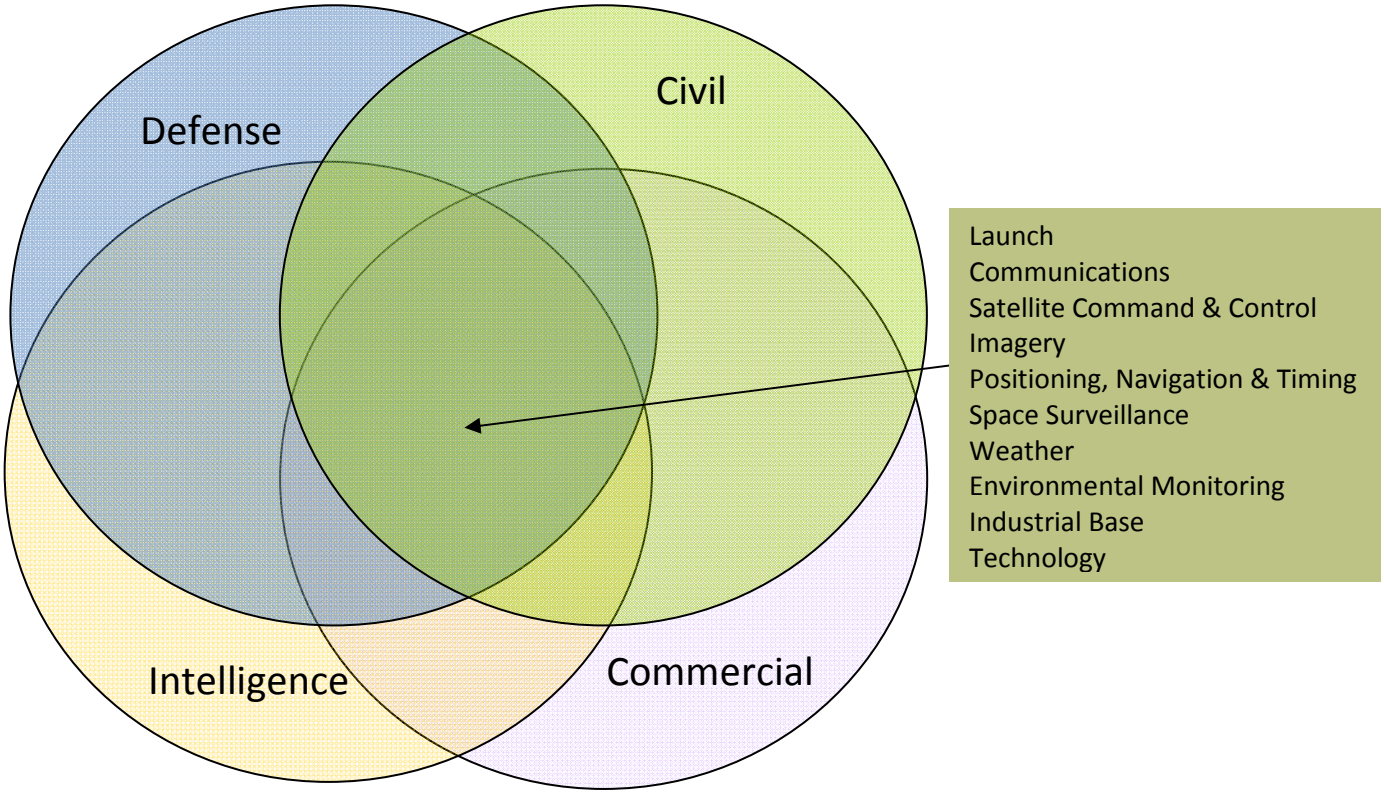
[4] See for example, Ted Molczan and John Pike, "Tables of Operational Military Satellites," *GlobalSecurity.org*, December 2005, http://www.globalsecurity.org/space/library/report/2005/satellitetables2004.htm.

government agencies worldwide are contracting space programs and services out to the private sector.[5]

(A.7) In addition to its critical role in providing systems and services to government, the space industry – though small compared to other manufacturing sectors – possesses strategic significance beyond its size. By generating knowledge and innovation, and by establishing new companies based on that information, the U.S. space industrial base is an important element of national security and in generating the nation's economic growth.

(A.8) The U.S. must have unimpeded access to the technologies, both global and domestic, that are needed for developing, operating, and maintaining national security space systems. Though some – possibly most – of these technologies can be provided by the domestic science, technology and industrial bases, others, including critical systems, sub-systems and components, may only be available overseas.

Figure 1.1: Space sector interdependence



Source: CSIS Defense-Industrial Initiatives Group

[5] Michael Krepon, *Space Assurance or Space Dominance: The Case Against Weaponizing Space* (Washington, D.C.: The Stimson Center, 2003), 8-9.

(B) Commercial satellite services are critical to national security

Though space has been a facet of U.S. national security policy for decades, the United States today is more reliant on space programs and the international community is playing a larger role in space. These factors elevate the importance of space within U.S. policy considerations to an even higher level. In August 2008, Scott Large, then-head of the National Reconnaissance Office (NRO), summed up the argument:

> "Today, America's concept of national security space no longer encompasses only classified and unclassified defense and intelligence space systems, but includes all forms of space systems (including civil and commercial), as well as a growing use of foreign space capabilities . . . In the information age, private global communications form the backbone of America's economic well-being. Additionally, these systems carry a large percentage of the nation's military data, critically augmenting America's military satellite communication architecture. This blending of commerce and defense data transmission demonstrates the commercial space sector's national importance. Although civil, commercial, classified and unclassified space systems support different missions, each has unique capabilities that play vital roles in maintaining America's financial and military security."[6]

Thus, the NRO recognized that commercial satellite services are integral to the national security of the United States as well as American life and commerce.

Services provided by the commercial space sector are thoroughly embedded in the American "way of life." Communications, banking, weather, and navigation systems all rely on the commercial space sector. Very few, if any, Americans are not affected by the commercial space sector on a daily basis. The importance of maintaining the critical infrastructure providing this capability cannot be overestimated.

Regarding national security, current and projected military operations are inextricably linked to commercial space assets. Recent DoD war games, such as the Marshall Institute's *A Day Without Space* exercise and the Schriever War Game Series, have brought key senior leaders together to demonstrate and underscore the criticality of the commercial space sector.[7]

One recent news article, entitled "DOD's reliance on commercial satellites hits new zenith," highlighted the importance of commercial space to U.S. national security.[8] The communications bandwidth needs of the U.S. State Department, the U.S. Department of Defense, and U.S. coalition forces have increased tremendously during the past 20 years, and military satellite communications capacity falls far short of meeting demand. As a result, the U.S. government

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[6] Scott Large, "National Security Space Collaboration as a National Defense Imperative," *High Frontier* 4, iss. 4 (August 2008), 3-5.

[7] George C. Marshall Institute and the Space Enterprise Council, "A Day without Space: Economic Security Ramifications," http://www.marshall.org/article.php?id=778.; Wyle, "Wyle Experts Play Vital Role in Recently Completed Schriever Space Wargame," July 24, 2009, http://www.wyle.com/news/2009/07-24.html.; Marty Kauchak, "Q&A: Lieutenant General Larry D. James," *Military Space & Missile Forum* 2, iss. 6 (November/December 2009), http://www.kmimediagroup.com/msmf-archives/213-msmf-2009-volume-2-issue-6/2198-qaa-lieutenant-general-larry-d-james.html.

[8] Barry Rosenberg, "DoD's reliance on commercial satellites hits new zenith," *Defense Systems*, February 25, 2010, http://www.defensesystems.com/Articles/2010/03/11/Cover-story-The-Satcom-Challenge.aspx.

now relies on commercial satellite providers for 80 percent of its total capacity to meet mission requirements, and according to multiple sources, up to 96 percent of satellite communications for the military in battle arenas such as Iraq and Afghanistan are provided by commercial communications satellites.[9] And the need continues to increase. According to a recent Institute for Defense Analyses (IDA) study, the communications bandwidth employed for Operation Iraqi Freedom today is more than 100 times the bandwidth employed at the peak of the first Gulf War.[10] New data-intensive applications, such as Unmanned Aerial Vehicles (UAV), weapons targeting, and data transmission platforms are increasing bandwidth requirements.[11]

In addition to communications, commercial space assets provide a critical supplement to U.S. government imagery capabilities. The National Geospatial-Intelligence Agency (NGA) acquires images from commercial imagery satellites and disseminates them to government consumers. These capabilities provide high-quality imagery (down to about a half meter resolution) and substantial imaging capacity beyond that of government Intelligence, Surveillance and Reconnaissance (ISR) satellites. They also offer unclassified imagery, allow government ISR satellites to focus on critical targets, and provide timely supplements to government satellite imagery. NGA has bought high-resolution imagery of hundreds of millions of square kilometers, and is planning to expand commercial imagery purchases as part of a broader strategy to meet U.S. national security imagery needs.[12] Significantly, commercial imagery is now part of the formal national security imagery architecture**.**

Beyond communications and imagery, the Department of Defense is considering a broader range of payloads on commercial satellites. These could support almost the full range of space missions, including positioning, navigation, and timing; weather and environmental monitoring; communications; or ISR.

DoD's reliance on the commercial space sector, already extensive, is very likely to continue to grow. The *Space Posture Review: Interim Report*, issued in March 2010, makes clear that DoD and the Intelligence Community are interested in making substantial use of commercial space capabilities in the future, and the report clearly illustrates that demand for bandwidth is only projected to increase.[13] With continued overseas operations that rely critically on imagery and

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[9] Ibid; David Cavossa, Charles Edwards, Kevin Gallo, BG Tip Osterthaler (ret.), and Michael Wheeler, "New Approaches to Commercial Satcom Procurement: Fulfilling the Needs of the USG and DOD" (panel discussion at the Satellite 2010 Conference, National Harbor, Maryland, March 16, 2010).

[10] Institute for Defense Analyses, *Leadership, Management, and Organization for National Security Space: Report to Congress on the Organization and Management of National Security Space* (Alexandria, VA: Institute for Defense Analyses, 2008).

[11] "Over 80 percent of U.S. Military Capacity provided by Commercial Satellites, " *Satellite News*, May 20, 2009, http://www.allbusiness.com/defense-aerospace/aerospace-industry-space/12473258-1.html.; Peter B. de Selding, "U.S. Government Missing Hosted Payload Opportunities," *Space News*, March 26, 2010, http://www.spacenews.com/civil/100326-govt-missing-hosted-payload-opportunities.html.; "Looking to the Future of Satellite Bandwidth Procurement," *Military Information Technology* 13, no. 5 (June 2009), http://www.military-information-technology.com/mit-archives/182-mit-2009-volume-13-issue-5/1705-looking-to-the-future-of-satellite-bandwith-procurement.html .

[12] "Up Front: DNI Blair Announces Plan for the Next Generation of Electro-Optical Satellites," May 29, 2009. https://www1.nga.mil/Newsroom/Pathfinder/0703/Pages/UpFrontDNIBlairAnnouncesPlanfortheNextGenerationofElectro-OpticalSatellites.aspx.; Jeff J. Leonard and Lynn Mueller, "Commercial Imagery Strategy Focused on End-User," *Directions Magazine*, November 8, 2007, http://www.directionsmag.com/article.php?article_id=2607.

[13] Office of the Secretary of Defense and Office of the Director of National Intelligence, "Space Posture Review: Interim Report," March 12, 2010.

communications, national security reliance on space-based capabilities has become "pervasive, sophisticated, and important."[14] The same will be increasingly so for commercial space capabilities.

(C) Therefore, <u>though never before explicitly stated</u>, assured and secure access to space for key commercial assets is also a national security imperative

CSIS concludes that the dependency of our national security on commercial assets in space merits consideration of an assured access policy for key parts of the commercial space sector. Assured access is defined as "a sufficiently robust, responsive, and resilient capability to allow continued space operations, consistent with risk management and affordability."[15]

The conclusion that assured access to space also applies to commercial assets was not fully embraced in the most recent U.S. Space Transportation Policy, issued by President George W. Bush on December 21, 2004. At that point, assured access was delineated as a requirement only for critical national security, homeland security, and civil missions. In fact, the past two decades of U.S. national space policies have consistently pointed out the connectivity between commercial space and national security. They stop short, however, of stating the next logical step: since commercial services are vital to national security, assuring commercial access to space in order to ensure provision of those services is therefore a national security imperative. CSIS can find no official policy statement that explicitly conveys the U.S. policy of assured access to space to the commercial space sector.

(D) Seven principal concerns regarding commercial access to space emerged from the CSIS review, bolstered by extensive interviews with government, industry, and academia

The United States relies more heavily on satellite services than any other country in the world, and U.S. national security is already highly dependent on commercial satellites. Dependence translates to vulnerability if access to these vital services can be interrupted, either in the short or long term. If no such vulnerability exists and none is foreseen, policymakers and decisionmakers have no cause for concern. Unfortunately, this does not appear to be the case. During CSIS interviews with senior leaders, several current and potential issues related to space launch services for commercial satellites were repeatedly raised. These included:

(D.1) Limited access to U.S. launch opportunities for commercial satellites

Commercial satellite launch customers face significant challenges in getting manifested at U.S. launch ranges and, when they are manifested, in holding a reliable launch date. Despite national policy guidance, domestic launch services have become effectively inaccessible to commercial satellites, due in large part to these scheduling challenges.[16] National Security Presidential Directive (NSPD) 40 on Space Transportation Policy recognizes the importance of a healthy

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[14] Institute for Defense Analyses, *Leadership, Management, and Organization for National Security Space*, 3.
[15] "NSPD-40 Fact Sheet: U.S. Space Transportation Policy," January 6, 2005, http://www.fas.org/irp/offdocs/nspd/nspd-40.pdf.
[16] While many interviewees expressed frustration with the inaccessibility of ULA to launching commercial payloads, the Air Force officially recognizes this concern. See: Air Force Space Command, <u>Enabling Concept for AFSPC EELV Launch Scheduling and Forecasting Process</u>, December 23, 2009.

commercial space launch industry in supporting U.S. economic interests, yet launches of government payloads completely dominate the United Launch Alliance (ULA) manifest through 2012. ULA has launched only one commercial satellite in the past four years, and no commercial launches are scheduled through 2012. Neither ULA nor the government appears highly incentivized to provide better access for commercial satellite launch customers.

(D.2) Potentially uncertain access to international launch providers

Geopolitical climates shift, which could potentially threaten access to international launch providers. The U.S. government has authorized launches of satellites with U.S. content by Arianespace and International Launch Services (ILS) that would otherwise be prohibited. International launch providers have always been willing to launch U.S. content satellites. In the future, however, neither the authorization to launch nor unrestricted access to foreign providers can be guaranteed.

(D.3) Fragile U.S. launch industrial base

Many government and industry sources have raised deep concerns related to the space industrial base. These concerns include the consequences of industry consolidation, weakness in the second and third tiers of the industrial base, the ability to attract qualified suppliers, reliance on foreign suppliers, and the ability of industry to attract and retain a qualified workforce.[17] Both the national security space and the commercial space sectors leverage the U.S. industrial base. To the extent that the industrial base is decaying and calling into question U.S. ability to put payloads on orbit, this is a national security concern.

(D.4) High and increasing launch prices for government and commercial satellites

The price of launch has increased significantly during the past three to five years for both government and commercial satellites.[18] This is true for both U.S. and foreign launch vendors. Because launch prices are not made public, the question of how much that price has increased is a matter of some disagreement among observers. Some estimate that it has increased by more than 50 percent, others somewhat less, but all observers agreed that prices have risen. Causes for that growth are hard to pin down.[19] Rising launch prices have been attributed to depletion of inventory, a lower number of launches annually, artificially low launch prices earlier in the decade, reduced competition, and (in the United States) a deteriorating second and third tier industrial base.[20]

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[17] See, for example: Office of Science and Technology Policy, Executive Office of the President, "Report to Congress on the Space Launch Industrial Base," December 22, 2009, http://www.whitehouse.gov/files/documents/ostp/press_release_files/OSTP%20Letter%20on%20Space%20Launch%20Propulsion-12%2022%2009.pdf.

[18] The cost of a launch and the price of a launch are two different things and should not be confused. The price is what a customer pays for launch; the cost is how much money the vendor spends to launch. It is quite possible that the actual cost of accessing space could decrease, but the price paid to access space would not reflect this.

[19] Henry R. Hertzfeld and Nicolas Peter, "Developing new launch vehicle technology: The case for multinational private sector cooperation," *Space Policy* 23, iss. 2 (May 2007), 81-89.

[20] See, for example: Gary E. Payton, Testimony before the House Armed Services Committee Strategic Forces Subcommittee, April 21, 2010.

(D.5) Payload security, including hosted payloads

While many observers suggested that payload security for overseas launches has become quite good, others noted past problems and that the security of commercial payloads critical to national security remains a serious issue. CSIS found no study verifying foreign intrusion of a satellite payload prior to launch by a foreign provider in the past decade. Alternatively, the shift to hosted payloads—putting sensitive military, civil, or intelligence payloads on commercial satellites—might increase the potential for intrusion simply because hosted payloads are higher value targets and require greater security.

(D.6) Potential grounding of a class of launchers should there be a catastrophic event

Launching satellites is a complex enterprise, relying on unique equipment and infrastructure. Disruption of launch services due to a catastrophic event is a constant concern. An unprecedented string of launch failures from 1984 to 1987, including the Challenger shuttle disaster, led to a general suspension of launch until root causes could be determined. Flight operations were resumed, but only after a suspension of all satellite launches for 32 months. Today, the U.S. launch industry provides only two medium to heavy launch vehicles, the Atlas V and the Delta IV. Catastrophic failure of either could lead to an extended grounding and a reliance on only one launch vehicle; catastrophic failures of both types of launch vehicles—historically not an implausible event—could ground the entire U.S. launch fleet. Similarly, the majority of commercial GSO launches today are accomplished by only two foreign launch providers—ILS and Arianespace, and a disaster that disables either of the two could have the same effect.

(D.7) Long term implications for U.S. national security if current plans and policies are not changed

Many interviewees expressed the concern that the United States lacks a consistent, comprehensive national space policy or an executable strategy that would provide the basis for continued U.S. leadership in space. In the absence of such a policy and executable strategy, U.S. leadership may wane, with serious consequences both for the U.S. economy and U.S. national security. While reflecting on the lack of a coherent U.S. national space policy, the same individuals were also quick to note the growing internationalization of space. During the past 50 years, the United States has been the technological and commercial world leader in space, but the landscape is changing. Companies in the United States are in direct competition with many foreign entities in space in virtually all areas: launch vehicles and services, remote sensing satellites, telecommunications satellites of all kinds (voice, direct TV, fixed and mobile services), and navigation services. The technological capability to build and operate sophisticated space equipment has spread worldwide.[21] While competition is not necessarily a concern for the U.S. economy or national security, what is of concern is the potential loss of U.S. leadership in space as a result.

[21] Henry R. Hertzfeld, "Globalization, commercial space and spacepower in the USA," *Space Policy* 23, iss. 4 (2007), 210-220.

PART II. Launch Industry Today:

The state of today's space launch industry has been heavily influenced by non-market forces that have led to atypical market behavior.[22] These dynamics help to shape the global environment in which space services are produced, including the U.S. and foreign launch industry; impact the cost and price of space launch; and ultimately affect commercial and government access to space—all areas of concern identified by CSIS in its research and interviews. An understanding of these factors will also be important in considering the options to improve access to space. The dynamics are most relevant when examined in the context of U.S. national policy directives, demand expectations, and supply capacity.

(A) U.S. space polices and directives have contributed to market uncertainties

Several key documents establish policies that are significant to the launch industry. These include the National Space Policy of 2006, the U.S. Space Transportation Policy, and the Commercial Space Launch Act. While most of the policies embodied in these documents support the notion of expanding commercial launch options, not all of them have had a salutary impact on the launch industry or have provided better launch access for commercial satellites. In fact, most appear to have had a minimal impact, in part because they work toward varying and occasionally inconsistent goals.

The National Space Policy of 2006 issued by President Bush requires U.S. departments and agencies to use "commercial space capabilities and services to maximum practical extent;" to acquire commercial services when they are available and meet U.S. government needs; to increase private sector participation in the design and development of U.S. government space systems and infrastructure; and to ensure that U.S. government "space activities, technology, and infrastructure are made available for private use on a reimbursable, non-interference basis to the maximum practical extent, consistent with national security."[23]

The National Space Policy could be interpreted as providing a robust basis on which to justify government actions to support commercial access to U.S. space launch infrastructure and to encourage the development of commercial space launch services. At the same time, the policy illustrates the inherent tension between government launch priorities and providing support for commercial launch. The Department of Defense and the Intelligence Community have strongly prioritized government launches over commercial launches. This fits with the policy that such support for commercial launch is to be tendered on a non-interference basis consistent with national security requirements, but it has been implemented in a manner that does not promote new U.S. entrants into the launch market, nor provide commercial satellite launch consumers with predictable access to U.S. launch services. Such tensions might be resolved by the establishment of an executable space strategy, but such a strategy has never been established, nor

[22] Several interviewees contended that non-market forces (e.g. the predominant influence of government in the launch industry) are so strong that space launch is not aptly described as a "market."
[23] "NSPD-49: U.S. National Space Policy," August 31, 2006, http://www.fas.org/irp/offdocs/nspd/space.pdf.

does an adequate governance structure exist that could guide space activities and implement such a strategy.[24]

It is also worth noting that beyond the official presidential directives on space activities, many other social, technological, budget, political, and economic actions are decided by all three branches of the federal government. Some are related to space issues, but are handled through other venues. Anti-trust reviews, for example, performed by the Department of Justice and the Federal Trade Commission, often have far-reaching space implications when dealing with firms engaged in space activities.

The list of direct and tangential actions with an impact on space spans virtually the entire spectrum of government activities, from securities regulations to decisions from the courts. Many of these actions are taken for very valid purposes that are unrelated to space, but can work at cross-purposes to space policies prescribed in presidential directives. Alternatively, they may create incentives for other nations or companies in other nations to develop systems more aggressively in direct competition with U.S. capabilities. Taken collectively, these actions may make consistent execution of a U.S. national space policy very difficult. Additionally, in so far as non-space policies and actions may have stimulated the development of robust space capabilities in other nations, they may have weakened U.S. economic leadership in space, and diluted U.S. dominance in space technology, systems development, and space applications.

The U.S. Space Transportation Policy (NSPD 40) predates the 2006 National Space Policy, but is entirely consistent with a focus on commercial services and support. It states that "the United States Government is committed to encouraging and facilitating a viable U.S. commercial space transportation industry that supports U.S. space transportation goals, benefits the U.S. economy, and is internationally competitive." But NSPD 40 also emphasizes the use of Evolved Expendable Launch Vehicles (EELV) for U.S. government medium and heavy launches. Establishing a national launch capability as a strategic interest is neither unwise nor inconsistent with the practices of other space-faring nations. However, focusing on the importance of and reliance on the EELV has had a significant impact on commercial launch access in a manner that has tended to undermine the goals defined in NSPD 40.

First, this focus has contributed to a reliance on a single launch provider for U.S. government medium and heavy space launch. Support for two EELV launch providers during the 1990s and early 2000s was predicated on a launch market far larger than ever materialized. The collapse of the business case for low earth orbit communications networks left both Boeing and Lockheed Martin competing for far fewer launches than they had anticipated, and they ended up producing launch vehicles sooner than they were ultimately needed. Neither could remain profitable in the new, less robust launch market. This situation led to the establishment of the United Launch Alliance (ULA), a business entity combining the Lockheed Martin and Boeing launch businesses. The merger was intended to ensure that the launch needs of the national security community would continue to be met; find efficiencies by combining business operations, manufacturing practices, and launch infrastructure of the two primary launch providers; and make certain that the new entity had enough business to sustain launch proficiency. Some

[24] Committee for U.S. Space Leadership, "Memorandum for the President: America's Leadership in Space,", March 10, 2009. In this white paper, the Committee calls for such a strategy.

observers believe that the establishment of ULA has resulted in significant savings, but ULA launch prices have risen in the past several years. Several interviewees voiced concern that a monopolistic, anti-competitive arrangement now exists between ULA and its potential customers.

Second, the emphasis on EELV within the Space Transportation Policy has created an anchor-tenant relationship between the U.S. government and ULA. ULA, by contract, provides launch services for government launches. The government prioritizes its own launches and allows commercial satellite launches only on a non-interference basis. ULA supports the Boeing and Lockheed Martin commercial launch companies when able, but many of those interviewed suggested that it has minimal incentive to provide support for commercial launch. This contention appears to be validated by the fact that ULA has supported only one commercial launch in the past four years.

In contrast to policies that have led to reliance on a single launch provider, the Commercial Space Launch Act (CSLA), first passed in 1984 and last amended in 2004, was intended to create a legal environment that would stimulate additional competitive launch providers to enter the market, facilitate investment in technology to enable enduring space access, and to encourage further development of U.S. launch sites and launch support facilities. In the six years since the CSLA was last amended, one can conclude the following: the CSLA has failed to stimulate new private entrants into the launch market; DoD policies and actions with respect to encouraging commercial vendors to enter the market are ambiguous at best; and DoD planning and budgeting for new technologies that might encourage new entrants appears inadequate.

One key reason for the lack of new entities into the launch market is that the technical, financial, and economic barriers to market entry are very high. The cost, complexity, and extended time frame related to the development of a new launch vehicle, the difficulty of dealing with government regulations, the lack of access to government infrastructure, the lack of near term return on investment, and uncertain prospects for long term returns are serious disincentives to new potential market entrants.[25] The more benign legal environment established by the CSLA may simply be insufficient to overcome these barriers. Moreover, the recent amendments to the CSLA focus heavily on legal matters related to the growth of commercial manned flight (space tourism), a focus that has not benefited the commercial launch industry. The one new entrant into the launch market, Space Explorations Technologies (universally known as Space-X), appears not to be motivated by the space tourism market. Another potential entrant, Virgin Galactic, is focused exclusively on space tourism, has not developed an orbital space vehicle, and appears not to be relevant to the commercial satellite market.

One observer described DoD's policies and actions with respect to stimulating new market entrants as "schizophrenic." On the one hand, DoD encourages consolidation in the launch industry, by supporting the ULA merger. On the other hand, DoD is also supporting market competition by encouraging Space-X as an alternative to ULA. At the same time, both DoD planning and research and development funding for launch technologies, another path to supporting new entrants into the launch market consistent with CSLA goals, appear inadequate. DoD has no technology or system roadmap for current and future launch needs. Such a roadmap

[25] National Security Space Office, "Barriers to Entry and Sustainability in the US Space Industry," February 2008, http://www.acq.osd.mil/nsso/industrialBase/Barriers%20Survey%2020Feb08.pdf.

would provide a guide for industry investment, provide a timeline for new entrant integration into the market, and could improve the efficiency of systems needed for access today. Past initiatives, such as the 2001 Space Launch Initiative and the 2002 Operational Responsive Spacelift Initiative, foundered and were either cancelled outright or withered away. Today, DoD has multiple pockets of minimal funding for disparate and seemingly unlinked propulsion technologies.

(B) Demand for launch services appears unrelated to price and reliability, the primary criteria on which launch contracts are awarded

Launch demand has been relatively flat for several years, and is expected to remain so for the foreseeable future.

Trends in launch demand, however, seem to have little correlation with factors that customers of space launch value from a launch provider. In other words, improvements on the supply side of the economic equation may be unlikely to generate additional demand for launch.

Above all else, U.S. government launch consumers value launch reliability. This relates directly to the cost of launch failure to the government. This cost is most significantly operational: because of the fragile state of many U.S. national security satellite constellations, a launch failure could result in a critical gap in capability. The cost is also in part economic—military and intelligence satellites can be hugely expensive, so much so that the cost of launch is insignificant compared to the operational and financial cost of losing a satellite. Government demand for launch, therefore, seems unlikely to increase if launch reliability improves.

During CSIS interviews, commercial satellite launch consumers affirmed three factors that guide their decisions about sourcing space launch, all related to the profit potential of payloads. These factors, in order of priority, are launch price, technical reliability, and schedule reliability. Lower launch price improves the corporate bottom line and competitiveness. Technical reliability reduces the chance of a lost satellite and lost revenue stream, and launch schedule delays in turn delay revenue streams. Here again, however, improvements in these factors by a launch provider may impact the decisions about which launch provider to use, but seem unlikely to generate additional demand.

Overall launch demand appears to be most closely related to growth in national security and commercial applications in space. While national security requirements for space-based capabilities continue to grow, this has generally translated into deployment of more capable satellites in small constellations. Incremental capability has been added largely by increasing satellite size and using more advanced technology rather than increasing the number of satellites. Launch demand has been further suppressed by extending the design life of satellites, reducing the need to replace them as often. In a sense, the launch industry is caught in a loop—because launch is expensive, the government generally opts for fewer, very capable satellites.[26] This in

[26] "Col. Jim Nugent, deputy division chief for responsive space at Air Force Space Command, says that the traditionally high cost of launch has led the Air Force to focus on 'very capable and high density' satellites that are more expensive and longer-lived. These payloads don't require frequent launches." See: Breanne Wagner, "Market slow-down: low cost space launch vehicles await lift-off," *National Defense,* June 1, 2008, http://www.thefreelibrary.com/Market+slowdown:+low-cost+space+launch+vehicles+await+liftoff-a0180028720.

turn limits launch rates, which keeps launch costs and prices relatively high, and generates demands for additional expenditures to enhance mission assurance out of the fear of losing an expensive satellite.

Commercial applications, particularly in communications, have also grown at a rapid rate, but this growth has not generated demand for a larger number of launches. Again, the increased demand for communications services has been met, principally by larger, heavier, more capable satellites. This tendency toward larger satellites has increased demand for mass-launched-per-year, which has grown steadily. Since 1994, average mass per satellite has grown from 2,300 kg to 4,350 kg and annual demand likewise has almost doubled from 53,000 kg to 103,000 kg. However, the annual number of launches is about the same as in 1994, and is expected to decline somewhat, from 27 launches in 2009 to less than 20 per year during the next 10 years.[27]

(C) Dynamic supply capacity has created and continues to create unstable, unpredictable, and inefficient cost and price pressures

The factors associated with supply capacity have created and will continue to create unstable, unpredictable, and inefficient price and cost dynamics. The two dynamics with the greatest impact are new, non-market entrants to the supply and United States government purchasing practices.

U.S., Russian, and European launch providers (ULA, ILS, and Arianespace, respectively) have sufficient manufacturing capacity to meet expected global, regional, and U.S. launch needs. Beyond these suppliers, one commercial company, Space-X, is entering the launch market, and another, Sea Launch, is trying to reenter the market after its expected emergence from bankruptcy. In addition to China, however, other nations including Japan, India, and South Korea, are also developing and deploying launch capability. Launch capabilities are generally developed by nations, not companies, and are developed for fundamentally national rather than commercial reasons (such as assured access to space capabilities, avoiding reliance on foreign nations for space transportation needs, driving economic growth and technological progress, and national pride). Launch capabilities are either operated by governments with little attention to cost, or are given a commercial veneer and subsidized by governments in order to sustain an industry that may not be commercially viable.[28] These motivations lead to a global excess in space launch manufacturing capability and skewed pricing for commercial launches.

As more non-market driven launch providers offer launch services, excess capacity can create diverging cost and price pressures. Additional capacity from non-market players will create downward price pressures. As individual government subsidies from those interested in establishing national or regional capabilities increase, that downward pressure will continue to mount. However, previous investment in fixed-launch infrastructure will actually create an upward cost pressure. With more providers and constant launch demand, launch providers would have to amortize fixed costs over fewer launches. These costs may either be passed to the satellite customer or subsidized by interested governments. This phenomenon has been present

[27] Office of Commercial Space Transportation, *2009 Commercial Space Transportation Forecast.*

[28] For example, the Khrunichev Research and Production Space Center (which produces launch vehicles for ILS) is a Russian "Federal State Unitary Enterprise," a corporation set up by the Russian government to meet Russian government goals.

during the last decade and a half, as supply has outstripped demand and commercial launch vendors have suffered.

Concerning U.S. supply, the U.S government is the largest customer of U.S.-provided launch vehicles. Although U.S. government launch demand is relatively stable, the government buys launch services for individual launches, and procurement practices prevent the government from block purchases of launch vehicles, as would be the practice in a commercially-driven market. Thus ULA cannot anticipate government demand, and cannot plan production or order components from its sub-tier contractors effectively. Consequently, launch vehicle production is inefficient and the cost of production is high compared to what it might be in support of a commercial market. Foreign providers buy launch vehicles based on multi-year projections, reaping significant savings and making them more cost-competitive in the commercial market. Some experts estimate that inefficiency in U.S. production adds a 30 to 40 percent premium to U.S. launch costs; this premium clearly hurts the competitiveness of U.S. launch in the commercial launch market. Other experts have noted, however, that in light of its dependence on U.S. government launches, U.S. industry may be financially incentivized toward these inefficient practices since its profits are based on a percentage of the total cost.

Another impact of the dominance of non-market influences on supply is the apparent inability to determine launch costs accurately. Whereas commercial entities are strongly concerned with and influenced by efficiency (a function of service and cost), governments tend to be more impressed by effectiveness (a function of mission success). Calculation of costs in any government enterprise is often problematic, and understanding actual space launch costs is often of secondary importance to mission success and sustaining a capability necessary for national security and other non-commercial reasons. All launch services are subsidized, and government assistance and subsidies used to sustain launch enterprises further cloud the cost picture. Some interviewed by CSIS noted that the ULA contract structure intertwines infrastructure (owned and sustained by the government) and marginal costs so thoroughly that understanding the ULA cost structure is problematic. Others noted that ILS and Sea Launch may have had similar difficulties in accurately assessing their own costs. In the absence of accurate cost data, launch pricing can be either arbitrary or simply inaccurate. This may have been a contributing factor in launch prices earlier this decade: those prices may have been artificially low simply because providers didn't understand their own costs.

(C.1) Lack of reliable access to launch suppliers effectively reduces launch supply

While manufacturing capacity of launch vehicles may be ample, commercial satellite launch customers have a limited range of launch options available. Commercial access to U.S. and Chinese launch services are constrained, leaving Arianespace and ILS as the principal options. In the future, Sea Launch may be a viable option if it successfully emerges from bankruptcy.

U.S. launch vehicles have an extraordinary record of reliability during the past decade. This has resulted in part from the national security community's priority on and continued investment in mission assurance. Not surprisingly, given the dominance of the U.S. government as a launch customer and the U.S. government's focus on mission assurance, the systems and processes for U.S. launch range and operations have been primarily developed around government requirements and culture. Many believe that this has reduced access to launch ranges and added schedule risk for commercial launch customers.

These effects can be seen in launch scheduling, the current practice of which often prevents commercial entities from establishing reliable launch dates. The Department of Defense now reserves a launch slot with ULA 30 to 36 months before the launch is scheduled. Commercial customers more typically place launch reservations 24 months ahead of the anticipated launch date. Thus, ULA is fully booked for the next three years with government launches, and commercial customers seeking a launch slot are shut out. While DoD launches are often delayed, program offices often release those launch slots very late—a few months before the scheduled launch, not allowing commercial customers to take advantage of the newly opened launch slot, and leaving valuable launch opportunities unused. As government launch needs change, ULA is incentivized to meet those changing needs before it meets the needs of any commercial customer. DoD also tends to view specific launch vehicles as committed to a specific DoD launch; when program delays occur, those specific launch vehicles are often not released for commercial use. Finally, commercial launches have sometimes lost launch slots because launch schedules for higher priority government payloads changed.[29]

As a consequence, commercial satellite launch consumers have little confidence in their access to U.S. launch or in their ability to hold launch dates even if manifested. Several senior leaders among commercial launch customers and launch providers contend that government and ULA credibility with commercial launch customers is very low. Some suggest that neither the government nor ULA has much incentive to change their practices. Accommodating commercial satellite launches may detract from DoD's focus on and ULA's support of mission assurance, and some interviewees maintain that the government-ULA contract provides disincentives for ULA to support commercial launches.[30] The lack of structured, constructive dialogue between commercial operators and DoD launch range operators makes addressing some of these problems difficult.

Access to Chinese launch is restricted by U.S. export controls, which will be discussed more extensively shortly. In 1998, U.S. law placed satellites on the U.S. Munitions List controlled under the Arms Export Control Act.[31] Thus, the launch of satellites containing U.S. technologies by foreign launchers is prohibited unless the U.S. government authorizes it. These measures are intended to protect U.S. advantages in sensitive space technologies and protect U.S. national security. While the government has consistently provided such authorization for ILS and Arianespace, it has denied requests to launch satellites with U.S. technologies in China. This situation stems from an incident in 1996 in which two U.S. companies, Loral Space & Communications Ltd. and Hughes Electronics, provided assistance without an export license to China to help determine the cause of a Chinese launch failure. Many contend that this assistance helped China improve its military capabilities. Since then, some believe the U.S. refusal to authorize launches in China has become subject to a variety of political (national economic and foreign policy) considerations unrelated to protection of U.S. technology. Regardless of the reasons, for more than a decade commercial satellites with U.S. content have not been launched from China, further restricting launch options open to commercial launch customers.

[29] Commercial Space Transportation Advisory Committee (COMSTAC) Space Transportation Operations Working Group, White Paper on DoD Impact on U.S. Commercial Launch Services Competitiveness, December 23, 2009.
[30] CSIS has not reviewed this contract.
[31] Title XV, subtitle B – Satellite Export Controls," Strom Thurmond National Defense Authorization Act for Fiscal Year 1999, Pub. L. no. 105-261. 112 STAT. 1920. (1999).

(D) International presence in space is increasing, while U.S. leadership in space is eroding

The current global space industrial landscape includes rapidly emerging foreign space capabilities, and the United States does not control their proliferation. Moreover, there is a significant ongoing international cooperation in space that is occurring without the United States, and often without any Western involvement. As a result, U.S. preeminence in space is being challenged in many technology and industry areas. The current U.S. export control policy has not prevented the rise of foreign space capabilities, and in certain cases may have helped other countries to develop such capabilities.

The United States was once dominant among very few space-faring nations, but today the number of nations active in space is much larger, and continues to grow. Since 1999, the number of countries with indigenous positioning/navigation/timing systems has tripled and the number of countries with indigenous reconnaissance/earth observation satellites has doubled. A dozen countries are able to launch their own satellites, a number that continues to increase; and 38 countries have operational control over their own communication satellites. The following table presents the growth in global space capabilities.

Table 2.1: Growth in global space capabilities

No. of countries / Time period	Launch own satellite(s)	Launched human spaceflight	Own positioning/ navigation/timing system	Launched own recon / earth observation satellite(s)	Control over own communications satellite(s)
1980	8	2	2	5	10
1999	11	2	2	14	32
2010	12 (+Iran)	3 (+China)	6 (+China, India, EU, Japan)	27	38
2011-25	Steady growth	India, ESA, and Japan active	Full operationalization of EU, Asian systems	Steady growth	Steady growth

Source: CSIS Defense-Industrial Initiatives Group

The increasing quality of foreign space assets is as important as their rising number. For example, Russia, France, Israel, South Korea, and India all possess commercial imaging satellites capable of one meter resolution or better. Canada, the European Space Agency (ESA), Italy, Germany, and Japan possess civil radar imaging satellites, and India and Argentina are positioned to join this group. China has launched two military radar imaging satellites, and Israel has launched one.

Though the United States is clearly ahead of the rest of the world in terms of military space capabilities, other nations, including U.S. allies, are developing similar capabilities. Several European countries, including France, Germany, and Italy, have developed dedicated military satellites for communications and earth observation based largely on their civilian space

programs. The European Union, ESA, and other partners are developing the Galileo satellite navigation system to compete with the U.S. Global Positioning System (GPS).

In the global commercial communications satellite market, where the United States had a technical and qualitative lead over the international competition in the 1990s, global competitors have closed the gap in the last decade. Since 1998, European and Asian manufacturers of satellites have gone from delivering satellites that were smaller, had fewer transponders, and had less payload power and shorter lives to manufacturing satellites of equal weight, number of transponders, payload power, and lifespan.

In addition, international collaboration to improve space capabilities that excludes U.S. participation continues despite U.S. policy. Sino-Russian cooperation, Russian-European cooperation, Russian-Indian discussions, and the China-led Asia Pacific Space Cooperation Organization are examples of international cooperation in space that do not involve the United States as a partner.

(D.1) U.S. export control policy has probably encouraged the growth of foreign space capabilities

U.S. export control policies have long been a matter of controversy, but the consensus among those interviewed by CSIS is that these policies continue to be a significant driver in the evolution of space capabilities, markets, and industrial capabilities. As U.S. International Traffic in Arms Regulations (ITAR) are applied to space technologies, the launch of satellites with U.S. technology content by foreign launch providers is prohibited unless the U.S. government authorizes such a launch. The avowed purpose of this restriction is to protect against the transfer of sensitive satellite technology to foreign countries, with the twin goals of protecting U.S. advantages in space technology and preventing the use of this technology by U.S. adversaries to the detriment of U.S. national security.

Expert opinion is divided about whether such restrictions enhance or inhibit U.S. national security capabilities. Some have maintained that when a nation launches rockets, military or commercial, its military capabilities are enhanced. Others contend that several commercial launches a year do little to enhance military capabilities. Some note that the United States has launched many payloads with foreign launch vendors and developed very robust security procedures to protect sensitive U.S. technologies. Others note the growing sophistication of foreign intelligence threats and a potential for cyber intrusions which are difficult to counter. Some believe that export controls have kept technologies which benefit U.S. national security out of foreign hands. Others have argued that other nations have developed their own technology base in response to U.S. export controls, undermining U.S. security.

Whether these nations would have developed new space technologies in the absence of U.S. export controls is moot. It is clear, however, that many countries have been undeterred by U.S. export control policy, and some have used those controls as a catalyst to develop indigenous space capabilities. For example, China's decision several years ago to create a China-centric space community stems in part from the fact China has been barred from launching satellites with U.S. components. By 2007, China had partnered with Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, and Thailand to develop an earth observation satellite system, had organized a satellite association in Asia (the Asia Pacific Space Cooperation Organization), and

had designed, built, and launched a communications satellite for Nigeria.[32] It also launched a Chinese-built communications satellite for Venezuela in 2008.

Europeans also view the U.S. export control regime as a catalyst for some of their space activities. Daniel Sacotte, head of ESA's Human Spaceflight program, was quoted in 2005 as saying, "It's a shame, but it's not for me to comment on U.S. law, only to note its effects, and for the Rover [the U.S. Mars probe], ITAR would have made cooperation too complicated to be feasible. … We are now obliged to develop our autonomy in various areas, which is no bad thing … We may also find partners besides NASA."[33] In line with this announcement, the ESA is funding the development of a European supplier of solenoid valves in order to remove that U.S. part from European space propulsion systems. The Spanish company CASA developed its own capability to supply reflectors as part of the European ITAR-free space technology movement (it previously had limited capability), and today it is a global competitor in reflectors technology.

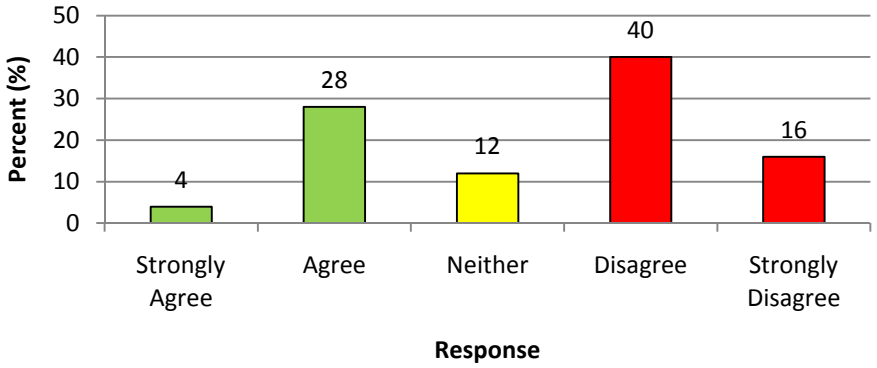
Similarly, Indian Prime Minister Manmohan Singh proudly announced to the Indian Space Research Organization (ISRO): "It is a matter of particular pride that international technology denial regimes have not impeded your efforts—in fact, they have spurred you to greater heights."[34]

U.S. companies also believe that export controls make penetration of foreign markets more difficult. As demonstrated by the responses of U.S. space executives to a survey conducted by Booz, Allen & Hamilton in 2006, U.S. companies are frustrated by the uncertainty involved in complying with ITAR. Fifty-six percent of respondents disagreed or strongly disagreed with the statement that export controls are easy to understand; 71 percent disagreed or strongly disagreed with the statement that the time it takes to process an export control request is predictable; and 85 percent agreed or strongly agreed that this lack of clarity and unpredictability in the process hinders their ability to make strategic business decisions.

[32] Jim Yardley, "Snubbed by U.S., China Finds New Space Partners," *The New York Times*, May 24, 2007, http://www.nytimes.com/2007/05/24/world/asia/24satellite.html.
[33] Quoted in: Peter B. de Selding, "National Insecurity: ITAR and the Technological Impairment of U.S. National Space Policy," *Journal of Air Law and Commerce* no. 74.
[34] Indian Space Research Organization, "Space India- Newsletter," September 21, 2005.

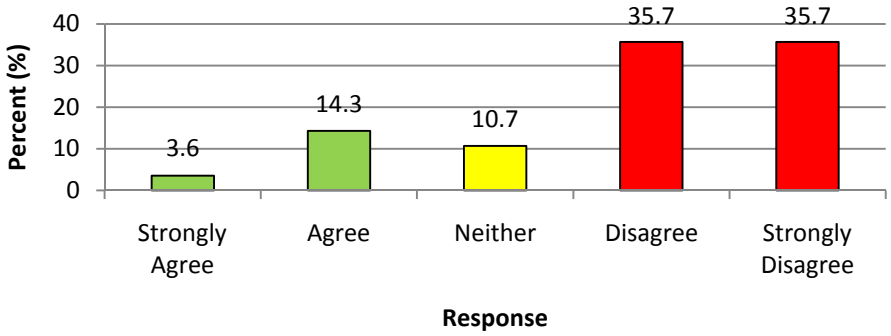
Figure 2.1: U.S. companies find it difficult to participate in foreign markets (part I)

It is easy to understand ITAR licensing requirements for a defense article or service



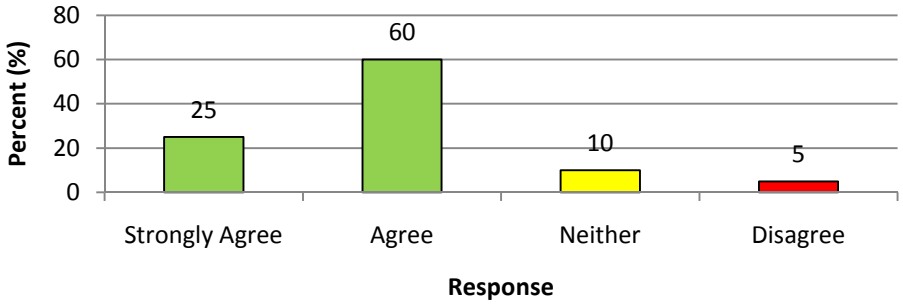
Source: Booz Allen survey of U.S. industry executives, May 2006

I can predict with confidence the amount of time it takes for my company to obtain an export license from my government



Source: Booz Allen survey of U.S. industry executives, May 2006

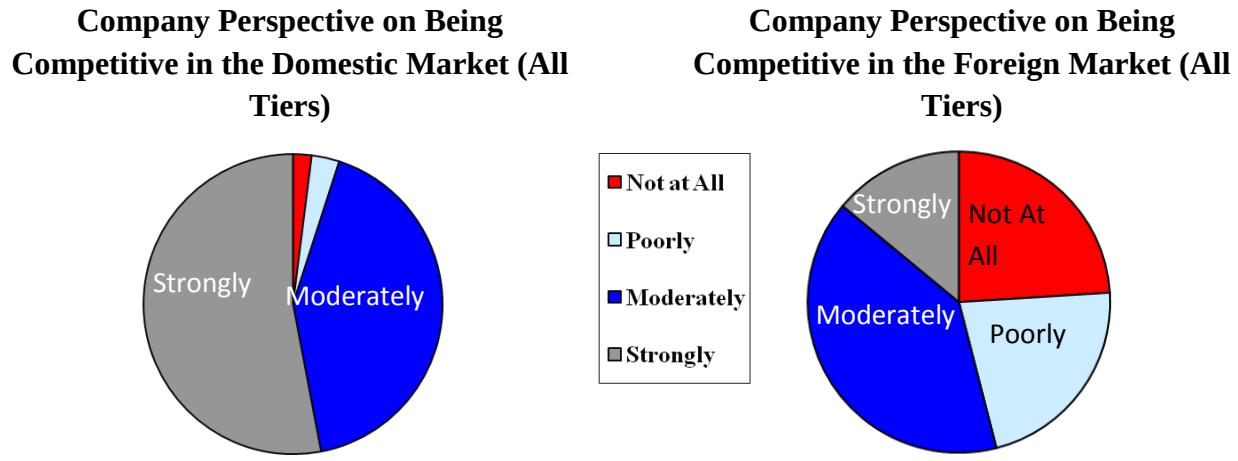
The unpredictable amount of time that it takes my company to obtain an export license hinders my company's strategic decision making



Source: Booz Allen survey of U.S. industry executives, May 2006

More recently, the Air Force Research Laboratory (AFRL) survey of U.S. space industry executives found that U.S. export controls affect the space industry's confidence concerning its ability to compete in foreign markets. Though the vast majority of U.S. companies are confident of their ability to successfully compete in the domestic market, close to 50 percent feel they are poorly or not at all equipped to compete in foreign markets.

Figure 2.2: U.S. companies find it difficult to participate in foreign markets (part II)

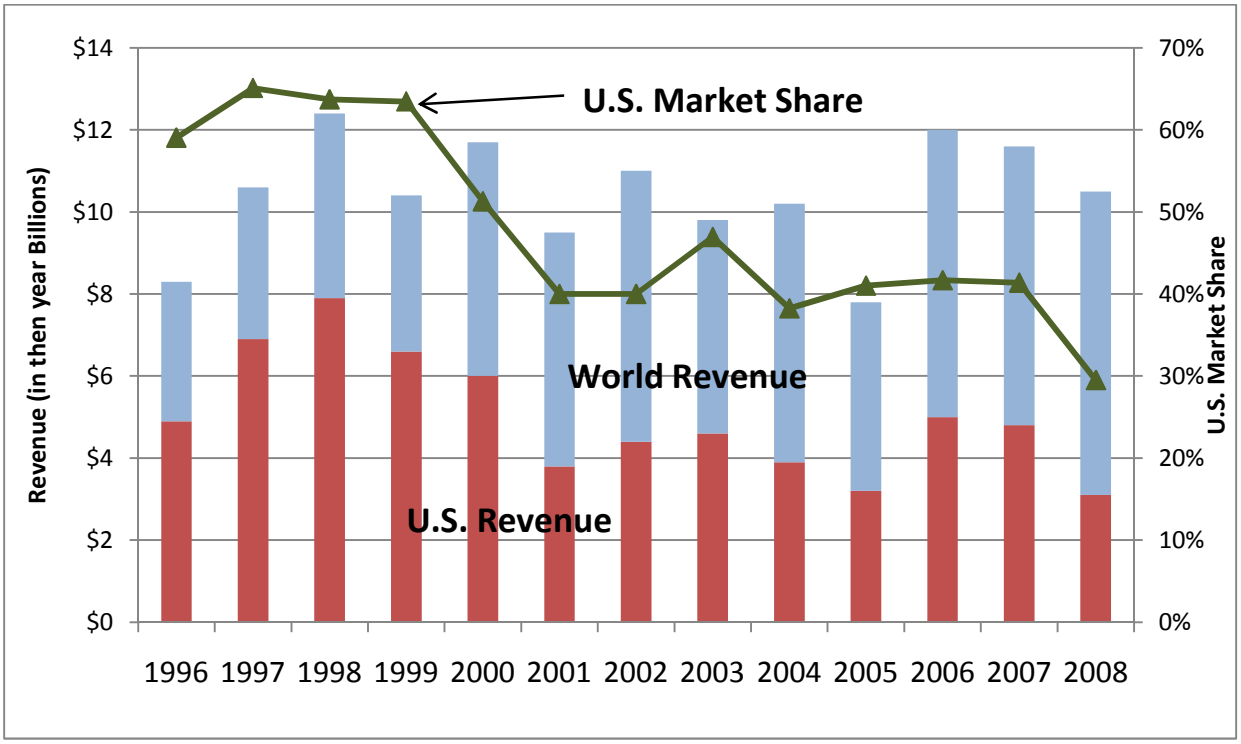


Source: Air Force Research Laboratory analysis of survey of 202 space companies/business units, 2007

(D.2) U.S. dominance in space is eroding

Since the late 1990s, the U.S. share of both the global launch market and the global commercial satellite market has eroded significantly. A combination of factors described in this report, some within U.S. control and some not, have contributed to this erosion, including the high cost of U.S. systems, export controls, contradictory or poorly executed policy, and processes and practices that limited the use of U.S. systems and encouraged the growth of foreign capabilities. Many studies describe this decline. Data gathered by the Satellite Industry Association through 2009 reflects this trend, as displayed in Figure 2.3.

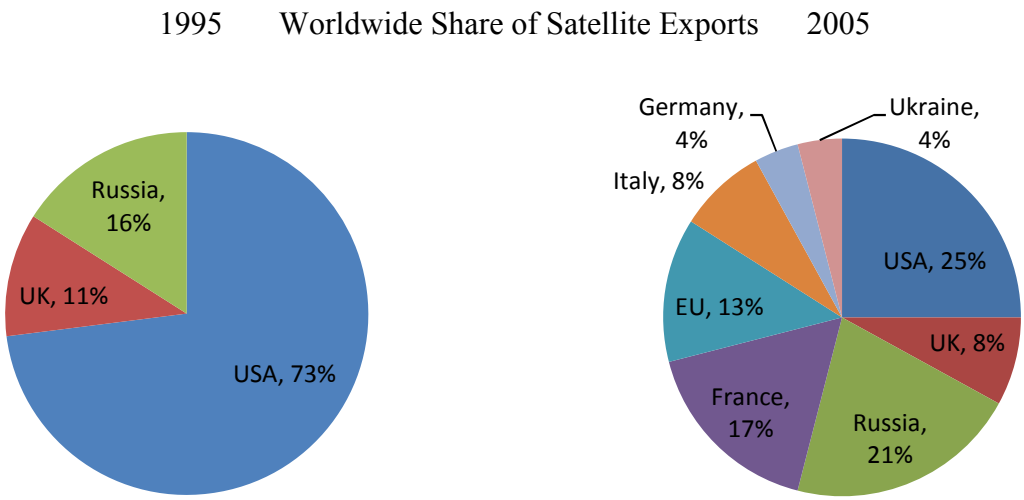
Figure 2.3: U.S. dominance in space is eroding (part I)



Source: Satellite Industry Association, 2005 through 2009 reports

Similar data have been collected by the National Air and Space Intelligence Center (NASIC), as shown in Figure 2.4.

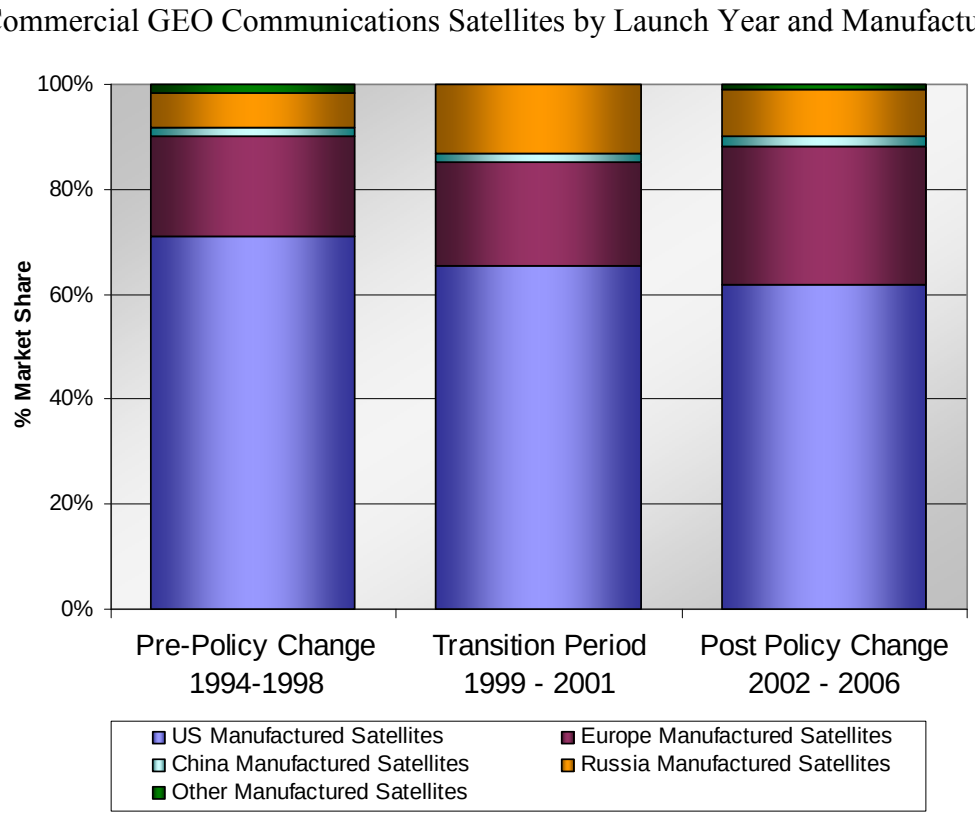
Figure 2.4: U.S. dominance in space is eroding (part II)



Source: National Air and Space Intelligence Center, 2006

As reported by the U.S. Air Force, the Federal Aviation Administration's (FAA) Office of Commercial Space Transportation Database paints a similar picture in Figure 2.5.[35]

Figure 2.5: U.S. dominance in space is eroding (part III)



Source: FAA Office of Commercial Space Transportation Database, as reported by the U.S. Air Force, 2007

Lastly, the Institute for Defense Analyses (IDA) has collected data on specific space programs and the companies to which they were awarded, presented in Table 2.2.[36] For commercial communications satellites, the table shows a clear trend away from buying U.S. satellites. In fact, officials in various European and Canadian organizations have specifically noted that they wish to produce and procure "ITAR-free" space systems so as to avoid any dealings with U.S. export control regulations.[37] Examples of space technologies that are now touted as "ITAR-free" include European apogee motors, thruster control valves and star trackers, microwave components on Astrium's Megha-Tropiques mission, and the Alcatel satellite bus.

[35] "Defense Industrial Base Assessment: U.S. Space Industry Final Report," August 31, 2007, http://www.bis.doc.gov/defenseindustrialbaseprograms/osies/defmarketresearchrpts/exportcontrolfinalreport08-31-07master___3---bis-net-link-version---101707-receipt-from-afrl.pdf.

[36] Institute for Defense Analyses, "Export Controls and the U.S. Defense Industrial Base", October 2008, http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA490280

[37] Note: For example, see: Peter B. de Selding, "European Satellite Component Maker Says It is Dropping U.S. Components Because Of ITAR", *Space News*, June 13, 2005, http://www.spacenews.com/archive/archive05/Sodern_061305.html.

Table 2.2: U.S. dominance in space is eroding (part IV)

Major Commercial GEO Satellite Programs

	Program	Customer Country	1990 - 1999	2000-2008
Switch Post ITAR	Apstar	Hong Kong	BBBS	SA
	Intelsat	International	BBBBLSSSSSSSSSSLLLLLLL	SSSSSSSSEL
	SES Astra	Luxembourg	LBBBBBBB	BEBABLL
	Telesat Canada	Canada	LLL	BLBEE
Switch Pre ITAR	Chinasat	China	BC	C
	Inmarsat	International	EEEELLLLL	EEE
	JCSat	Japan	JBBB	BL
	Panamsat	USA	BBBBBBBBUBBBBBBBSSB	BBBOOAL
	SES Americom	USA (Now Luxembourg)	LLLELL	LLLLALLLLAAL
Captive US Market	Asiasat	Hong Kong	BLBB	BS
	BSAT	Japan	BB	OOO
	DirecTV	USA	BSB	BSSSS
	Echostar	USA	LLLLLS	SLSL
	Loral Skynet	USA	LLLSSSS	SSS
	New Skies Satellites	Netherlands		LLBOB
	XM	USA		BBBB
Captive Foreign Market	Arabsat	Middle East	AAAA	EE
	Eutelsat	Europe	AAAAAAEEAEEE	AEAAAAETA
	Express	Russia	NN	NNNNNNNN
	Insat	India	III	IIIII

A:	Alcatel
B:	Boeing
E:	EADS
I:	ISRO
J:	JSAT
L:	Lockheed
N:	NPO PM
O:	Orbital
S:	Space Systems Loral
U:	ASC Contel (UK)
T:	Telespazio

US WIN
ROW Win

Source: Institute for Defense Analyses, 2008

(D.3) The U.S. space industrial base is showing significant weaknesses as a result of the growth of foreign competition and weak demand

The U.S. space industrial base is largely dependent on U.S. government (primarily national security) budgets. U.S. government spending (both national security and civilian) on space systems in 2005 totaled $36.635 billion.[38] This represents 1.8 percent of the 2005 federal budget, or 0.3 percent of 2005 GDP. However, within the U.S. space industrial base, the market share dominated by the U.S. defense and intelligence community customers is more akin to naval shipbuilding or tanks than to aerospace or other parts of the defense industry. About 60 percent of sales for first- and second-tier companies are to national security customers, and these numbers would be even higher if they included all government customers (i.e. civilian government agencies such as NASA and NOAA). This implies that the national security community in effect "owns" the U.S. space manufacturing industry.

The health of this industry thus depends on direct government support (akin to an "arsenal strategy") and/or policies that encourage and enable it to participate more effectively in the global market place in order to broaden its economic base. To date, the U.S. government has been unwilling to nationalize the industry, has not generated sufficient demand on its own to sustain competition (via multiple suppliers) in key technology niches, and has been unable to enforce or execute policies that provide for broader participation in the global market.

As a result, the United States has seen an extraordinary consolidation in its space industry.[39] The United States has one launch provider and two principal satellite builders. There are identified weaknesses in the second and third tiers of the U.S. space industry, areas in which only one domestic supplier exists. These weaknesses are particularly acute if that supplier is financially weak, or if there are a small number of financially weak suppliers. This is the case in critical areas such as lithium-ion batteries, solar cells (including solar cell substrates), traveling wave tubes, visual imagers, optical coatings, read-out integrated circuits, and infrared focal plane arrays. According to one report, within five years, half of the current subcontractors could exit the space business or cease to exist at all.[40] It is worth noting that healthy second and third tiers are important given the role they play in generating innovation. While the large primes spend about 1.5 to 2 percent of their revenues on internal research and development (IRAD), the second and third tiers spend between 5 and 15 percent of revenues on IRAD. Restrictions on competing in the global market result in fewer dollars available for IRAD.

There are also looming issues with the space-related workforce, particularly with the next generation of employees. The existing workforce is aging, and one area where this is particularly

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[38] National Aeronautics and Space Administration, *Aeronautics and Space Report of the President: Fiscal Year 2005 Activities* (NASA, 2006), http://history.nasa.gov/presrep2005.pdf. 101.

[39] "Maintaining a healthy space industrial base is a matter of critical importance to our national security. In the history of the space age we have rarely been so reliant on so few space industry suppliers. Many suppliers are struggling to remain competitive as demand for highly specialized space components dwindles due to a niche government customer-base." Betty Sapp, *The Space Posture Review and the Fiscal Year 2011 National Defense Authorization Budget Request for national security space programs: Hearing before the House Armed Services Committee, Strategic Forces Subcommittee*, 111th Cong., 2nd sess., April 21, 2010.

[40] Jay DeFrank, "The National Security Space Industrial Base: Understanding and Addressing Concerns at the Sub-Prime Contractor Level," Space Foundation, 2007, http://www.spacefoundation.org/docs/The_National_Security_Space_Industrial_Base.pdf.

obvious is that of program managers, program directors, and system engineers. Experience with many programs of varying characteristics is highly desirable to "grow" competence in these areas. Because the number of space programs has declined and the pace of development slowed, the ability to generate the skills for those roles has diminished.

(E) Conclusions

In addressing the reasons why decisionmakers should care about commercial access to space, CSIS concluded that commercial space is now critical to U.S. national security. It also highlighted seven concerns raised by those we interviewed. Our findings validate these concerns.

- **Commercial access to U.S. launch capabilities is clearly limited.**
- **U.S. policies have restricted access to foreign launch. Two foreign launchers, ILS and Arianespace, are predominant. Should policies in the United States, Russian, or France shift, access could become more difficult or even narrower.**
- **Launch prices have increased over the past three to five years, although the cause of those increases is not clear. Launch prices in the United States are much higher than foreign launches.**
- **The U.S. space industrial base is fragile. In the future, the industrial base may not be able to support critical U.S. military or commercial needs.**
- **Some experts believe that foreign launch of sensitive payloads constitutes a security risk; others disagree.**
- **Two foreign launchers provide most commercial satellite launches. Should either of the two launch systems suffer a failure, commercial launch would rely on a single system—a dangerous circumstance.**
- **Little in the execution of U.S. policy over the past decade provides confidence that negative trends will be corrected.**

PART III. Option Sets to be Analyzed for Improving Commercial Access to Space:

The heavy reliance of our military and intelligence communities on commercial space is now widely recognized, and a consensus is building that, as a recent Institute for Defense Analyses report stated, "a more strategic approach in planning for and employing commercial satellite capabilities" is needed.[41]

CSIS has concluded that assured access to space for these critical capabilities should be a matter of concern to U.S. decisionmakers, both because of the importance of these capabilities to U.S. economic and national security and because of concerns about current and potential problems related to commercial access to space that were widely expressed by experts interviewed by CSIS. An important aspect of CSIS' charter is to provide insight into policy solutions to those decisionmakers. Thus, based on discussions with experts, as well as future policies, directives, and actions currently under consideration by the Administration, CSIS has summarized four option sets intended to improve commercial access to space. These options sets are:

[41] Institute for Defense Analyses, *Leadership, Management, and Organization for National Security Space*, 19.

- Leveraging foreign launch providers;
- Increasing domestic U.S. competition;
- Expanding the U.S. government role in space launch; and
- Enhancing launch demand.

These option sets collectively encompass the range of options under consideration within the Administration and as reflected by those interviewed by CSIS during this project. They represent broad policy approaches that were discussed, advocated—and opposed—by various interviewees, and cover, we believe, the full range of options open to decisionmakers. Not all the option sets are mutually exclusive. Many specific actions could be taken to implement them, and the list of possible actions included in this report is not meant to be comprehensive. Nor are all of these actions necessarily exclusive to a particular policy approach; some are common to more than one.

CSIS has not, in this report, undertaken a detailed analysis of the options. Nor has CSIS recommended a course of action. CSIS' intent in this report is to help define the trade space available to improve commercial access and put that trade space in a broad policy context. CSIS has, however, also developed a structured framework for analysis and evaluation of the options to improve commercial access to space, presented in Part IV of the report. This framework offers policy analysts and decisionmakers a set of criteria against which the options and specific actions could be judged. We believe that the factual, policy, and evaluative context laid out in the report can provide a comprehensive template to help inform decisionmakers in their complex task of directing policy and programs in this important area.

(A) Option Set I: Leverage Foreign Launch Providers

Multinational alliances and globalization across the entire commercial space sector, especially in the communications satellite segment, have increased tremendously, presenting both new challenges and opportunities for U.S. national security.[42] The March 12, 2010 *Space Posture Review: Interim Report* states, "Growing international and commercial interest and expertise in space presents opportunities for the United States for further collaboration and partnership in support of U.S. national security space activities, and the global community at large."[43] This option set explores two ways to leverage foreign launch providers—(a) the U.S. government may enter into explicit partnerships with foreign providers to assure launch for commercial and government payloads; and/or (b) the U.S. government may reevaluate and remove certain export control policies and regulations.

While the analysis and evaluation of this option set focuses on improving commercial launch customers' access to space, the policies and actions regarding foreign launch providers have been in the past—and most likely will continue to be—used to leverage trade policy, technology control and innovation policy, geopolitics, and national security. U.S. government interaction with foreign launch providers has a complex history, often following several avenues at once, and often at cross purposes.

[42] Linda L. Haller and Melvin S. Sakazaki, "Commercial Space and United States National Security," (2001), http://www.fas.org/spp/eprint/article06.html.
[43] "Space Posture Review: Interim Report."

(A.1) Possible actions

Recognizing the importance of commercial launch capabilities internationally and nationally, the U.S. government could explore avenues to leverage the world launch market by entering into strategic partnerships.

Current U.S. government international cooperation—including DoD partnerships to conduct space operations—is a patchwork of agreements that vary according to the nations involved and make collaboration among multiple partners more difficult. This patchwork reflects the simple fact that there is no coherent, structured U.S. government strategy for commercial space access that can create synergies within international relationships. The *Interim Report* notes, "The long history of cooperation in civilian space programs and U.S. government partnerships with commercial space service providers can serve as a foundation for collaborative global action to shape the future space environment."[44]

One example of such collaboration would be a U.S. government-Arianespace, ILS, Great Wall Industry Corporation (GWIC), or India Space Research Organization (ISRO) partnership to utilize foreign launch sites and assure launch access prioritization. The U.S. government would enter into negotiations to assure mutual access to and sharing of industrial base capacities and capabilities. Such arrangements could begin with national security assets or commercial satellites with hosted payloads. The main goal would be to view the launch enterprise as a global one, with a global industrial base and global interests. One goal, from a U.S. perspective would be to ensure it maintains access to space in the face of technical launch problems or natural or man-made disasters affecting U.S. launch sites.

Leveraging foreign launch providers and improving access for commercial launch customers faces a significant challenge in the complex system of U.S. export control laws and regulations, which fail to acknowledge the dynamics of global space commerce. On Capitol Hill, several efforts[45] are underway to move satellites and related components from the State Department-administered U.S. Munitions List (USML) to the Commerce Department-administered Commercial Control List (CCL). These endeavors complement broader efforts in the executive branch to reform the "byzantine amalgam of authorities, roles, and missions scattered around different parts of the federal government"[46] and update antiquated Cold War restrictions found in the Arms Export Control Act and Export Administration Act.

The CSIS report of 2008 recognized this lack of strategy, acknowledged the challenge of outdated export restrictions, and offered nine recommendations, updated as necessary:

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[44] Ibid.

[45] U.S. House of Representatives, *Foreign Relations Authorization Act, Fiscal Years 2010 and 2011*, 111th Cong., 1st sess., 2009, H.R. 2410. Included language to strengthen America's satellite industry, as did U.S. House of Representatives, *Strengthening America's Satellite Industry Act*, 111th Cong., 1st sess., 2009, H.R.3840.

[46] Secretary of Defense Robert M. Gates, "Export-Control Reform," Remarks to Business Executives for National Security, Washington, DC, April 20, 2010, http://www.bens.org/mis_support/Gates%20Export%20Speech%204-20-10.pdf.

1. The Administration and Congress should review and reconcile the strategic intent of space-related export controls. Given the importance of space capabilities to national security, a key challenge has been the chasm between the Administration and Congress regarding the strategic intent of space-related export control policies and, as a corollary, the strategic role of international collaboration. Reconciling the differences between the President's policies and the legislation governing the trade in U.S. space technologies is critical to maintaining reasonable controls that help to safeguard U.S. national security.

2. Key to reconciling White House and Congressional policies is identifying and controlling those space technologies that are critical to national security. The Department of Defense should identify these technologies, which should then remain on the U.S. Munitions List and subject to the State Department's International Traffic in Arms Regulations.

3. Those space-related technologies that are not deemed by DoD to be critical to national security should be moved from the U.S. Munitions List to the Department of Commerce's Commercial Control List. Examples of such non-critical capabilities include commercial communications satellites and any subsystems and components specifically designed for commercial use.

4. The appropriate executive branch departments should study whether other space systems, components, technologies, and capabilities should also be removed from the USML and review the resulting list annually. Criteria during this study and annual review should include the criticality of items and their availability outside of the United States. The notion of doing such a periodic review of items on the USML is not new. In fact, the 1999 legislation that put satellites on the USML includes language to that effect.

5. Congress should amend legislation related to satellite export licensing and include in that language a requirement to adhere to industry best practices, such as set timelines, technology thresholds, *de minimus* rules, and special licensing vehicles for international cooperation.

6. The Secretary of Defense and NASA Administrator, in addition to the Secretary of State, should have the authority to grant case-by-case exemptions for anomalous resolutions deemed to be in the national interest. These exemptions should occur as quickly as practicable and apply for a specific period, as both the Department of Defense and NASA require the ability to solve mission-related problems where timely international collaboration can be critical.

7. Congress should create a special program authority—resident at the Department of State with coordination by the Secretary of Commerce, Secretary of Defense, and NASA Administrator—to permit timely engagement of U.S. participants in multinational space projects. This type of solution is currently in use in other communities of interest, such as the Joint Strike Fighter (JSF) program. In effect, such a program authority could create trusted communities for an international collaborative space program whose members—once vetted and deemed "safe"—would be exempt from specific space-related export controls.

8. Congress should increase the notification threshold for satellite exports and establish a mechanism to allow the threshold to adjust with inflation. In some cases, Congress has not adjusted thresholds in several decades, which fails to account for a variety of pricing factors including, but not limited to, inflation.

9. Relevant space-related government agencies should collaboratively undertake an annual assessment of their industrial base. This is related to the principle noted earlier in this report that all U.S. space activities are interrelated, which in turn means that analyzing them from the perspective of the entire community of government users is important. The Administration's Space Interagency Policy Committee manages the development and implementation of U.S. space policy, which includes commercial use of space and the defense industrial base as it relates to space. In addition, the Space Industrial Base Council—formed in 2007—includes many of the important actors and could be a venue for launching future analyses of the U.S. space industrial base.

(A.2) Potential benefits

"New opportunities for partnership and collaboration with both international and commercial space actors have the potential to support future national security space activities and enhance U.S. leadership."[47]

Forming alliances and encouraging cooperation with foreign entities could provide several benefits to the United States, including ensuring continued U.S. access to space after a technical failure or a launch facility calamity, strengthening the competitive position of the U.S. commercial satellite sector, enhancing the U.S. position in partnerships, and reinforcing collaboration among other space-faring nations.

As the Booz, Allen & Hamilton 2000 Defense Industry Viewpoint notes, strategic commercial alliances: (1) provide capabilities to expand quickly service offerings and markets in ways not possible under time and resource constraints; (2) earn a rate of return 50 percent higher than base businesses—"returns more than double as firms gain experience in alliances"; and (3) are a powerful alternative to acquiring other companies because they "avoid costly accumulation of debt and buildup of balance sheet goodwill."[48]

In those respects, international commercial alliances could help U.S. firms access foreign funding, business systems, space expertise, technology, and intellectual capital and increase U.S. industry's market share overseas, thus providing economic benefits to the United States. Moreover, U.S. experiences with foreign entities in foreign markets could help those entities obtain the requisite approvals to operate U.S. government satellite systems in other countries, resolve satellite spectrum and coordination issues, and mitigate risks associated with catastrophic domestic launch failures by providing for contingency launch capabilities from foreign nations.

Multinational alliances would also signal U.S. policymakers' intent to ensure U.S. commercial and military access to space within a cooperative, international domain, help promote

[47] "Space Posture Review: Interim Report."
[48] Linda L. Haller and Melvin S. Sakazaki, "Commercial Space and United States National Security."

international cooperation, and build support for U.S. positions within various governmental and business forums. First, partnerships could allow the United States to demonstrate greater leadership in mitigating those shared risks related to vulnerability of space assets through launch facility and data sharing, offering improved space situational awareness, establishing collective security agreements for space assets, exploring space deterrence and satellite security doctrines, and formulating and agreeing to rules of the road on the expected peaceful behavior in the space domain. [49]

Second, partnerships could also help the United States build consensus on important space-related issues in bilateral or multilateral organizations such as the United Nations, the International Telecommunication Union, and the World Trade Organization; working with emerging space-faring nations is particularly important because of their growing presence in the marketplace and participation in international organizations. [50]

Third, alliances could serve as a bridge to future collaborative efforts between U.S. national security forces and U.S. allies. For example, civil multinational alliances such as the International Space Station and the international search and rescue satellite consortium, Cospas-Sarsat, involve multiple countries partnering to use space for common public global purposes. [51] Finally, developing government, business, and professional relationships with people in other countries provides opportunities for the United States to further the principles upon which U.S. national security relies—competition, economic stability, and democracy.

In addition to encouraging partnerships with foreign providers, the U.S. government may choose to reevaluate and revise certain export control policies and procedures. As the key executive branch agencies charged with implementing export controls, the Departments of State, Defense, and Commerce have acknowledged the need for statutory and regulatory reform, including but not limited to possible changes to the International Traffic in Arms Regulations (ITAR) that implement the Arms Export Control Act (22 U.S.C. 2778). These departments continue to review existing export control statutes and regulations with a view toward reducing processing times and streamlining the licensing process. They also have focused in recent years on sensitive technologies like those in the satellite domain. For example, in 2007, the State Department's International Security Advisor Board (State ISAB) issued a report stating: "The Department of State should be prepared to facilitate international cooperation in the use of space through U.S. export policies. The Department of State, therefore, in its regulation of satellite exports, should focus on ways to streamline the licensing process. While it is obviously essential to protect U.S. national security and space control, the current process damages U.S. cooperation with friends and allies and weakens the U.S. commercial space satellite industry and the underlying industrial base that develops civil, commercial, military, and intelligence space assets."[52]

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[49] Eligar Sadeh, "Space policy questions and decisions facing a new administration," *The Space Review*, June 9, 2008, http://www.thespacereview.com/article/1146/1.
[50] Ibid
[51] Ibid
[52] United States Department of State - International Security Advisor Board, *Report on U.S. Space Policy*, (Washington, DC, 2007).

ITAR is a particularly significant topic among international interlocutors, which argue that these regulations are unnecessarily restrictive and time-consuming, and are counterproductive in that they promote foreign nation technology development and dissemination to the detriment of U.S. suppliers. U.S. executive branch agencies generally agree that ITAR is ripe for reform, noting that several nations that are close military and trading partners (e.g., the United Kingdom and Canada) have sought ITAR waivers for years. A 2007 State Department report states that: "The current International Traffic in Arms Regulations (ITAR) list is too broad. It includes too much technology that is widely available internationally. Moreover, a single international transaction involving commercial space technology now often requires multiple licenses. Licenses often come with extensive restrictions that make resubmission necessary, causing further delay and uncertainty for U.S. manufacturers in the commercial international market place."[53] One solution proposed by the ISAB is to review the ITAR list, regulate only key technologies and exporters, and issue broad licenses to streamline the process.[54]

In the last several years, the executive branch has undertaken numerous export control reviews with a push toward actionable recommendations. Most recently, President Obama formed an interagency task force in August 2009 to review export regulations, and during a March 2010 speech at a U.S. Export-Import Bank conference, he announced initial results of his Administration's efforts, noting that the "reform program will enhance national security by focusing on the enforcement of strict controls around the export of the most critical technologies and products, while strengthening the competitiveness of key manufacturing industries in the U.S. by streamlining the regulations that apply to their exports."[55] In April 2010, Secretary of Defense Robert Gates outlined an export control reform plan that includes "a single export-control list, a single licensing agency, a single enforcement-coordination agency, and a single information-technology system,"[56] with possible changes enacted before the end of the year. Although implementation details remain, including the extent and likelihood of needed legislation, this plan has the potential to significantly reform U.S. export control policies and administration.

These announcements broadly echoed sentiments expressed in former President George W. Bush's Technology Agenda, which stated, "The current high tech export control system is awkwardly structured, hindering U.S. businesses, while failing to strengthen our national security." In mid-2007, the Coalition for Security and Competitiveness, whose members include the Aerospace Industries Association and National Association of Manufacturers, presented a report on "Recommendations for Modernizing Export Controls on Munitions List Items" in which the Coalition members stated, "[T]he U.S. export control system must be modernized so that it is better able to respond quickly and effectively to evolving security threats, and promote our nation's continued economic and technological leadership."[57] The proposal recommended providing more resources and high-level attention to export controls while streamlining the

[53] Ibid.
[54] Ibid.
[55] Office of the Press Secretary, The White House, "President Obama Details Administration Efforts to Support Two Million New Jobs by Promoting New Exports," March 11, 2010, http://www.whitehouse.gov/the-press-office/president-obama-details-administration-efforts-support-two-million-new-jobs-promoti.
[56] Secretary of Defense Robert M. Gates, "Export-Control Reform."
[57] Coalition for Security and Competitiveness, *Recommendations for Modernizing Export Controls on Munitions List Items*, (Washington, DC: Coalition for Security and Competitiveness, 2007), http://www.securityandcompetitiveness.org/files/muntions_list_recommendations.pdf.

licensing process. Other studies on reforming export controls have been undertaken by the National Academies of Sciences, the Defense Science Board, NATO's Industrial Advisory Group, the Hudson Institute, the Heritage Foundation, CSIS, and others.

On space-specific topics, the current export control policy constricts U.S. engagement with the global community and feeds a growing separation between the U.S. space establishment and an emerging non-U.S. space establishment. Modification to export control laws could have numerous benefits across the space industry spectrum.

In scientific collaboration, evidence is amassing concerning the restrictions imposed by the U.S. export control regime. Nobel laureate George F. Smoot noted: "Collaboration between U.S. and European scientists is harder now than it was before U.S. technology-transfer rules were tightened in 1999 … U.S. government officials charged with reviewing bilateral or multilateral science projects have been so worried about being accused of letting sensitive technologies slip into the wrong hands that they have overcompensated."[58] William Gerstenmaier, NASA's associate administrator for space operations, put it more bluntly: "[Export controls cause] problems between us and our international partners that are really more of a problem than the benefit we are gaining by having the ... restrictions in there."[59]

The International Space Station (ISS) Independent Safety Task Force reinforced this position in its final report, which noted that: "[A] contractor workforce comprises the majority of the [International Space Stations] operations workforce and must be able to have a direct interface with the [international partners] IP operations team to assure safe and successful operations. Their interactions and their ability to exchange and discuss technical data relevant to vehicle operations are severely hampered by the current ITAR restrictions." In addition, the report noted that: "Currently the ITAR restrictions and the IP's objections to signing technical assistance agreements are a threat to the safe and successful integration and operations of the Station."[60]

To address national policy inconsistencies, President Bush authorized a National Space Policy on August 31, 2006—a policy which remains in effect today—that established an overarching national policy governing the conduct of U.S. space activities.[61] The National Space Policy set seven goals for the United States in space. However, some elements of the export control regulation remain in conflict with those goals.

For example, one of the goals of the National Space Policy is to "encourage international cooperation with foreign nations on space activities that are of mutual benefit."[62] However, the continuation of America's legacy of beneficial collaboration with foreigners is being impeded, as some critics pointed to a unilateralist tone.[63]

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[58] Quoted in: "Briefs," *Space News*, February 8, 2007.

[59] Quoted in: Brian Berger, "Export Rules Boost U.S. Civil Servant Role in ATV Mission", *Space News*, May 21, 2007.

[60] *Final Report of the International Space Station Independent Safety Task Force*, February 27, 2007, http://www.nasa.gov/pdf/170368main_IIST_%20Final%20Report.pdf

[61] "NSPD-49: U.S. National Space Policy."

[62] Ibid. 2.

[63] Amy Klamper, "Obama Space Policy to Emphasize International Cooperation," *Space News*, November 30, 2009, http://www.spacenews.com/policy/091130-obama-space-policy-emphasize-international-cooperation.html.

The National Space Policy also stated that departments and agencies of the U.S. government shall "refrain from conducting activities that preclude, deter, or compete with U.S. commercial space activities, unless required by national security or public safety."[64] For instance, "space-related exports that are currently available or are planned to be available in the global marketplace shall be considered favorably."[65] However, the U.S. Munitions List is not consistent with the current assessment of which space technologies should be controlled. Specifically, satellites and their components were placed on the U.S. Munitions List due to congressional action with the intent being to limit the spread of space technology. This has had the unintended consequence of encouraging the proliferation of space capabilities, and has not prevented the rise of other space powers.

National Space Policy has also affected U.S. competitiveness. The policy states that: "A robust science, technology, and industrial base is critical for U.S. space capabilities … Use U.S. commercial space capabilities and services to the maximum practical extent."[66] However, ITAR has had an adverse impact on the U.S. industrial and technological base, as it creates a friction for U.S. companies competing in the global market. The U.S. space industrial base has reported the loss of some $600 million per year, on average, between 2003 and 2006, and that money in turn feeds space development overseas in which the United States is not involved.

The National Space Forum 2008, sponsored by the Eisenhower Center for Space and Defense Studies at the United States Air Force Academy and the Center for Strategic and International Studies (CSIS), recommended that support for reform efforts for export control policies would enable the U.S. government to act on behalf of space companies to create and ensure an open, free-market environment in global space commerce. The current approach to export control of commercial space technologies prevents this from happening. The export control issue must be addressed at the level of policy by reforming the "rule set" for how ITAR is applied. The current January 2008 Presidential Directive on export control reform is a start, yet more is needed. Such an effort would encompass a reassessment of what technologies need to be controlled for export, and deal with issues of timing, review, transparency, and cost in the export licensing process.[67]

In sum, export control reform could put our national space policy on a more consistent footing.

(A.3) Potential challenges

"Leveraging partnership opportunities may lessen known risks, however they could also create a new set of complexities that must be carefully managed."[68]

U.S. companies are forming alliances with foreign companies, entering foreign markets, and investing U.S. dollars and resources overseas. At the same time, foreign companies are forming partnerships with U.S. businesses in the United States, entering the U.S. satellite market, and investing foreign dollars and resources in the United States. As a result of these trends, companies are becoming more global. One company may have multiple owners around the globe

[64] "NSPD-49: U.S. National Space Policy." 7.
[65] Ibid. 9.
[66] Ibid. 3.
[67] Eligar Sadeh, "Space policy questions and decisions facing a new administration."
[68] "Space Posture Review: Interim Report."

and one product may have multiple producers. That companies of one nation are gaining greater access to the business strategies, systems, products, and employees of companies from other nations is not necessarily of concern. Particular alliances or circumstances, however, could create national security issues. Any such potential concerns would depend on factors such as the nations, entities, policies, and technologies involved. In these situations, the U.S. government should balance national security and commercial space considerations, including enhancing U.S. competitiveness.

Greater globalization, instant access to and transmission of information, as well as the ability to communicate virtually anywhere anytime, may alter people's sense of national boundaries and allegiances. This shift could also give rise to new risks and threats that may require the imposition of additional—not fewer—controls.

Export control change is incremental, as underscored by the fact that executive branch agencies and Congress have been pursuing export control reform for years, without significant success. As noted above, senior officials, including the President and the Secretary of Defense, are advocating meaningful reforms. That said, significant congressional concerns remain, requiring difficult discussions within both the House of Representatives and the Senate. Other than initial recommendations to streamline the licensing process for certain technologies and eliminate obstacles for companies with dual- or third country-national employees, the Administration has yet to roll out its detailed, formal recommendations. On space-specific reform, the House of Representatives has already passed—twice—language that would reform the licensing process. These pieces of legislation have yet to move through the Senate, and given the current political environment, it is unclear whether substantive legislation will be considered, conferenced, and signed into law before the midterm elections in November.

(B) Option Set II: Encourage Competition Among U.S. Domestic Launch Providers

The second major option set for enhancing access to space involves encouraging more competition among U.S. launch providers. The U.S. government's role in this option set would be to encourage competition among extant and prospective entrants in the launch market as a means of expanding the launch options available to commercial satellite companies, and potentially to government launch consumers as well. Government would serve as an enabler, possibly by providing launch infrastructure and modifying launch range policies, practices, and processes to help U.S. launch companies improve service and lower cost. However, in this option, competition in the private sector would be the primary engine that drives lower costs and prices, improved service, technological innovation, and the availability of a wider range of launch options. It would also encourage U.S. and non-U.S. commercial launch consumers to use U.S. launch providers.[69]

Today, domestic competition in the launch market is very limited. ULA is the sole provider of medium and heavy lift to the U.S. government. No other providers compete directly with ULA in this capacity. Orbital Sciences Corporation provides light launch vehicles and launch

[69] "We believe that when we engage the engine of competition, these services will be provided in a most cost effective manner than when the government has to do it." Michael Griffin, former NASA Administrator. See: Michael Griffin, "NASA and the Business of Space" (Remarks at the 52nd Annual American Astronautical Society, November 15, 2005), http://www.nasa.gov/pdf/138033main_griffin_aas1.pdf.

services, a market sector in which ULA does not compete.[70] ULA also provides medium and heavy launch vehicles and launch services to the Lockheed Martin and Boeing commercial launch companies, which compete for launches of the commercial satellites. As noted, domestic competition in this arena also is anemic. Lockheed Martin and Boeing are often considered too expensive, and the lack of reliable access to launch dates is a serious liability. Further, the commercial satellite launch market is small and projected to remain so.[71]

Nevertheless, the presence of potential competitors suggests that domestic launch competition may be a realistic prospect. Space-X is developing both light and medium/heavy launch vehicles, is positioned to compete for launches with ULA and Orbital, and actively seeks to compete for both government and commercial launches. Space-X has conducted one successful light launch, and has sold additional launches to clients based on the expectation of further success.[72] Sea Launch, an international consortium that is 40 percent owned by Boeing (other stakeholders include companies in Russia, Norway, and Ukraine), is working to emerge from bankruptcy.[73] If successful, Sea Launch will provide competition for medium and heavy launch services for commercial satellites. The fact that Space-X seeks to enter this market and Sea Launch is seeking to reenter it indicates they believe they can compete and win in the launch business.

U.S. launch companies have demonstrated significant advantages over some of their potential competitors, including very high quality and reliability and long experience. The extraordinary success rates of the current family of Atlas and Delta medium/heavy launch vehicles demonstrate these advantages.[74][75] Nevertheless, Lockheed Martin and Boeing have not fared well in the competition for commercial satellite launches. Lockheed Martin has launched only one commercial payload in the past four years, and Boeing has launched none in that time frame. Two failings stand out: the inability of the government to provide reliable launch dates for commercial payloads, and the inability of commercial launch vendors to be price competitive. Finally, many observers have noted that the launch ranges are afflicted with old equipment and non-responsive processes that inhibit timely satisfaction of commercial satellite launch requirements.[76]

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[70] Orbital is developing a medium launch vehicle, the Taurus II, but it has not yet flown.
[71] Commercial Space Transportation Advisory Committee, Federal Aviation Administration, *2009 Commercial Space Transportation Forecast*, May 2009, http://www.faa.gov/about/office_org/headquarters_offices/ast/media/NGSO%20GSO%20Forecast%20June%203%202009%20lowres.pdf. 6.
[72] Space Exploration Technologies Corporation, "Launch Updates," http://www.spacex.com/launch_updates.php.; Peter Pae, "NASA deal launches start-up into big time," *Los Angeles Times*, December 25, 2008, http://articles.latimes.com/2008/dec/25/business/fi-rocket25.
[73] Sea Launch, "Sea Launch Home Page," http://www.boeing.com/special/sea-launch/.
[74] The Delta II medium launch vehicle hasn't failed since 1998, and the Delta IV and Atlas V launch vehicles experienced only two partial failures in their first 32 launches. See: "Boeing Launch Services: Mission Record," 2010, http://www.boeing.com/defense-space/space/bls/missions/index.html.; United Launch Alliance, "Atlas V Product Card," http://www.ulalaunch.com/docs/product_sheet/AtlasProductCardFinal.pdf.
[75] It should be noted that neither the Atlas V nor the Delta IV launchers are purely U.S.-made entities. Both are reliant on foreign sourced materials and components.
[76] These and other issues were spelled out in the December 2009 "White Paper on DoD impact on U.S. Commercial launch Services Competitiveness." See: Commercial Space Transportation Advisory Committee, Space

(B.1) Possible actions

The U.S. government could establish policies and take a wide range of specific actions that would help facilitate commercial U.S. launch while simultaneously addressing launch facility accessibility and cost and price competitiveness.

To encourage new entrants into the launch market, the government could:

> Allow new entrants in the launch market to compete for U.S. government launches. New entrants who have demonstrated reliable capability could benefit from the opportunity to compete for a larger number of launches. In providing this opportunity, the government could encourage a wider range of options open to both government and commercial launch consumers. NASA has already taken a step in this direction by awarding a contract to Space-X to resupply the International Space Station.

Many of the other government actions to enhance competition would focus on enabling commercial launch vendors to compete more effectively in the commercial launch market. To help provide more reliable launch dates for commercial launch vendors and the commercial satellite consumers of launch, the government could:

> Increase the launch capacity at the ranges and, as a matter of policy, reserve a modest but fixed number of slots a year for commercial satellite launches.
>
> Mesh the launch planning cycles for government and commercial launches. Nothing compels the government to use 30-36 month launch planning horizons, and given the uncertainty inherent in military and intelligence satellite development and launch schedules, this planning horizon may not be optimal. More coordinated planning horizons would allow commercial launch vendors a better opportunity to reserve launch slots.
>
> Cede launch slots earlier when launch delays for government payloads are recognized. This would provide more opportunities for commercial vendors to reserve launch slots when they become available.
>
> "Overbook" slots in the launch calendar with a primary mission and a backup mission, in essence recognizing that delays are a fact of life and providing more opportunities to schedule a launch.
>
> Support the development of alternative launch facilities. Six non-federal spaceports are already in operation, and another seven have been proposed.[77] While not all of these would be able to provide a full range of launch services, supporting the development of launch site alternatives could increase the availability of launch slots and, if the new sites successfully develop efficient range processes, potentially lower costs.

Transportation Operations Working Group, "White Paper on DoD Impact on U.S. Commercial Launch Services Competitiveness," December 23, 2009.

[77] Office of Commercial Space Transportation, Federal Aviation Administration, "State of the Commercial Launch Industry" (briefing to the NRO Mission Assurance Forum, Cocoa Beach, Florida, January 29, 2008).

To enhance range throughput, launch rate, flexibility, and responsiveness, the government could:

> Provide stronger support of range modernization. The government owns, operates, and modernizes the launch ranges. Previous modernization of the launch infrastructure has been only moderately successful and many facilities at the ranges are antiquated or obsolete.
>
> Modify range regulations and processes. Many changes have been suggested in the past, including ramping back excessive equipment requirements, making safety requirements more realistic, moving ahead with GPS range tracking, and making regulations pertaining to commercial and government launch consistent.[78] In his March 10, 2010 testimony before the Strategic Forces Subcommittee, Senate Armed Services Committee, Gen. Robert Kehler, Commander, Air Force Space Command, stated that the major goals of the Launch and Range Enterprise Transformation (LET) effort included the improvement of business practices to better support commercial partners. This echoed his 2009 testimony before the same subcommittee in which he expressed Space Command's understanding of the importance of "fostering the growth of commercial launch capabilities."[79]

To enhance the international price competitiveness of U.S. launch providers, the government could:

> Allow commercial launch vendors to charge commercial satellite customers the marginal cost of launch. This practice is not excluded as a matter of policy or regulation today. However, the current structure of the contract between the government and ULA intertwines fixed and marginal costs in a way that that does not permit marginal launch costs to be identified clearly. Renegotiation of the ULA contract would be necessary to allow only these marginal costs to be charged for commercial satellite launches. A further issue here is the sound stewardship of government funds, since the government would voluntarily pay a higher price for launch than commercial launch customer. While the government wants to secure itself the best cost, allowing launch vendors to charge only the marginal costs to commercial launch consumers could increase the number of launches by U.S. vendors, and in turn enhance production efficiency and lower cost for U.S. government launches**.**

[78] This and the previous solutions are discussed in "White Paper on DoD Impact on U.S. Commercial Launch Services Competitiveness." U.S. Space Command may be planning to implement some of these actions; see Air Force Space Command, "Enabling Concept for AFSPC EELV Launch Scheduling and Forecasting Process," December 23, 2009. The Launch Enterprise Transformation (LET) initiative may also address some these issues and solutions.

[79] Gen. C. Robert Kehler, USAF, *Military Space Programs in Review of the Defense Authorization Request for Fiscal year 2011 and the Future Years Defense Program: Hearing before the Senate Armed Services Committee, Strategic Forces Subcommittee,* 111th Cong., 2nd sess., March 10, 2010.; and Gen. C. Robert Kehler, USAF, *Military Space Programs in Review of the Defense Authorization Request for Fiscal year 2010 and the Future Years Defense Program: Hearing before the Senate Armed Services Committee, Strategic Forces Subcommittee*, 111th Cong., 1st sess., May 20, 2009.

(B.2) Potential benefits

All or some combination of the steps above could help U.S. launch vendors compete more effectively for commercial satellite launches and potentially provide better launch access to commercial satellite launch customers. In the near term, they could also incentivize ULA, the current government medium/heavy lift provider, to attend more effectively to the commercial satellite launch market. Better scheduling practices could improve launch date reliability. Range improvements could help U.S. commercial launch vendors improve launch rates, establish more reliable launch schedules, and lower launch prices. If encouraging competition is successful and U.S. share of launches increase, the U.S. industrial base could be become broader, more stable, and more innovative; launch prices could be contained; and launch of critical payloads would be less prone to a loss of service in the event of a catastrophic failure of a single launch vehicle.

(B.3) Potential challenges

The strategy of enhancing competition faces two fundamental challenges: 1) the launch market does not act like a true market; and 2) demand for launch services is limited. Both challenges could reduce the benefit of encouraging competition as a means of expanding launch availability to commercial launch consumers.

As noted previously, launch price in the international market is not necessarily closely related to launch costs and some have argued that space launch is so dominated by government intervention that it has never been and will never be a market driven by supply and demand. Thus, critics of this option could maintain that no matter how efficient U.S. launch vendors become, they will never be able to offer lower prices than government-owned or highly subsidized competitors.

Other critics might contend that encouraging competition is not an economically viable option. It could simply encourage a large number of launch providers to compete for a limited number of launches with little prospect that demand for launch will increase in the foreseeable future—a path that may not be economically sustainable. U.S. launch providers have only two potential markets to pursue, U.S. government launches and commercial satellite launches. NASA funds 10-12 launches per year; DoD funds about the same, only half of which are medium or heavy launches. Commercial satellite launch consumers require about 20-25 launches a year.[80] Launch forecasts are never made with certainty, but current forecasts do not indicate that demand will increase. Thus, prospects for the market growth appear modest. Many observers have noted that support for two EELV providers in the 1990s was predicated on the twin notions of a substantial commercial launch market and competition. When the commercial launch market did not meet expectations, neither vendor was able to sustain itself, finally resulting in the ULA merger of Boeing and Lockheed Martin.

A secondary implication of this situation is that a broader industrial base may not be, in the long term, a healthier industrial base. If market demand is not sufficient to sustain additional launch providers, an industrial base that expands in the near term may simply consolidate in the longer term as those additional providers depart the launch market.

[80] Office of Commercial Space Transportation, Federal Aviation Administration, "State of the Commercial Launch Industry."

(C) Option Set III: Increase U.S. Government Role in the Domestic Commercial Launch Market

To a significant degree, the strategy of increasing government support for and control over the domestic launch market is the inverse of the strategy of enhancing competition. Rather than relying on commercial competition among launch vendors to improve service and drive lower prices, the U.S. government itself would seek to set conditions that would assure the availability of launch services for both itself and commercial launch consumers. In this scenario, government, rather than competition, would become the "engine" to reduce costs and prices and drive technological progress.

This strategy could be executed in various forms. At one extreme, the government could take an arsenal approach, in which it would own and operate the facilities needed to build launch vehicles and infrastructure, integrate payloads and launch vehicles, operate the ranges, and conduct the launches. This study, however, will focus on a less intrusive approach. The fundamentals of this variant would include a conscious policy of limiting competition and acquiring launch services from one key vendor, optimizing government practices to reduce cost and enhance efficiency, and prioritizing the ability to launch commercial payloads from U.S. ranges.

This option would be intended to make today's practice—in which the government already relies very heavily on one key launch provider—more efficient and to match it with current policies. Some contend that today's policies are too inconsistent to be effective, supporting at the same time a single principal launch provider, the development of a domestic commercial launch industry, competition both within the United States and with foreign launch providers, and potentially cooperation with foreign launch providers. All of these approaches seek to provide higher quality launch services to both U.S. government and commercial launch consumers. However, a strategy focused on government support and control to improve commercial access to launch would be based on the contention that the launch market is too limited to support multiple competitors within the United States.

(C.1) Possible Actions

To rationalize the launch industry, the government could:

> "Pick a winner." This option rests on the contention that domestic competition in the launch industry is not viable. "Picking a winner" in essence requires the government to select and work with a single launch provider. Such a course would avoid potentially destructive price competition that led to significant financial losses for the Boeing and Lockheed Martin space launch companies last decade and may have driven Sea Launch into bankruptcy. This option does not necessarily rule out all competition: if the government concludes that Space X is a viable space launch alternative, a one-time competition might be possible. If the government nationalized space launch production facilities, future management competitions, similar to those now conducted by the Department of Energy for the management of the national laboratories, might also be possible.

To enhance technological progress in space launch, the government could:

> Increase government research and development funding. Such a course would be consistent with the government's role in the past. Because of the cost of such systems and the lack of immediate economic payoff, the U.S. government historically has been the funding source to develop more advanced space launch systems. Indeed, Space-X is the only privately financed space launch vehicle ever developed.[81] In the 1990s, the United States made a conscious decision to develop a new, more efficient family of launch vehicles based on legacy technologies; these became the Atlas V and Delta IV vehicles used today. At various times since then, DoD provided significant research and development funds (the Space Launch Initiative and the Operational Responsive Spacelift Initiative in the 2000s) to try to advance the state of the art in space launch. DoD still spends a significant amount on R&D for space systems, but most of this now focuses on the development of advanced satellite systems and funding for space launch technology in the FY 2011 budget is not robust. NASA cancelled its work on the Ares space launch vehicle this year, but has requested substantial funding for development of advanced launch technologies. Increased government R&D funding for launch systems would be based on an assessment that the Space-X development model is not viable in the future and a recognition that advanced space launch technologies will be needed to assure continued U.S. space leadership. Such an assessment potentially could push DoD space launch R&D to more historical levels.
>
> Incentivize the U.S. launch provider to innovate. This might take the form of contract incentives for the launch provider that reward the development of lower cost, more efficient, and more reliable launch technologies that offer better service for government— and thus commercial—launch consumers.

To reduce cost and price and help assure a stable supply of U.S. launch vehicles for commercial satellite operators, the government could:

> Acquire launch services in stable, lot buys. Today, DoD buys launches inefficiently, on an individual basis. That practice does not allow ULA to anticipate DoD demand and requires ULA to acquire support from its subcontractor base as though each launch is the only launch. Baseline acquisition of multiple launches would help stabilize the industrial base, particularly at the second-and third- tier levels, and allow more efficient acquisition of launch vehicles.
>
> Acquire launch vehicles in advance of identified DoD launch needs. Some observers have suggested that simply acquiring launch vehicles in block buys might reduce costs to a point that the commercial satellite companies would find U.S. launch vehicles much more price competitive. Buying in advance of DoD needs could further reduce the cost of launch vehicles. Unused capacity could then be sold to the commercial satellite market at lower cost, and lower launch prices would benefit the government.

[81] Virgin Galactic is currently developing a sub-orbital vehicle to be used for space tourism but has not yet tackled an orbital vehicle. See http://www.virgingalactic.com/; The cost of EELV development in the 1990s was shared by the government, Lockheed and Boeing.

To enhance range throughput, launch rate, flexibility, and responsiveness, the government could:

> Modernize the launch ranges and modify range regulations and processes. These steps could be very similar to those described in Option II. The intent would be to improve range throughput, enhance the ability to support commercial launches, and lower costs associated with the launch range to better attract commercial satellite launch consumers.

To enhance price competitiveness, the government could:

> Provide direct subsidies to the U.S. launch provider. A consistent theme in the interviews was that ULA launch services were not price competitive with those provided by foreign launch services. This lack of price competitiveness might result from any number of causes—inefficiencies, over-facilitization, inferior technology—but it might also occur because foreign launch competitors are simply more heavily and directly subsidized.[82] Providing a more substantial subsidy would lower the price of a U.S. launch for the commercial market.
>
> Allow the launch vendor to charge commercial customers the marginal cost of launch. This again would be intended to attract commercial launch opportunities, resulting in the potential for larger production runs for space launch vehicles, which should reduce per vehicle manufacturing costs, build a more robust industrial base, and allow for the amortization of range costs over a larger number of launches. The government could also reasonably expect to benefit from each of these results.

(C.2) Potential benefits

Other benefits might accrue from this approach in addition to lower launch prices. Stability—and thus a healthier industrial base—could be assured for the launch provider selected and supported by the government. The government's commitment to sustaining a viable launch industry would very likely offer assured and secure access to space from a domestic launch service. Such assured access would presumably extend to critical payloads on commercial satellites, and reduce the commercial launch consumers' reliance on foreign launch providers.

(C.3) Potential challenges

The strategy of enhanced government control faces two key challenges in implementation: incentivizing and enabling innovation and containing costs and prices.

The commonly accepted U.S. paradigm is that private enterprise and competition is the most effective means of encouraging innovation. While contract incentives for a single launch provider may suffice to encourage such innovation, a single provider in a secure relationship with its buyer may be more incentivized to continue performing successfully with proven technologies than to speculate on new technologies for marginal economic return or penetrating small and not very lucrative markets. The government's strong focus on mission assurance may also discourage innovation; relying on proven but perhaps less efficient technologies and

[82] All launch providers are subsidized in one form or another, at a minimum through provision of infrastructure. How much the various launch providers are subsidized and how subsidies affect competitiveness is not easy to determine. See Jeff Foust, "How Competitive is Commercial Launch?" *The Space Review*, October 19, 2009, http://www.thespacereview.com/article/1493/1.

processes may be safer than employing new technologies that promise improved performance. Government efforts to spur the development of new launch technology have certainly given rise to more powerful and more reliable rockets. At the same time, these efforts have not been notably successful in producing technical or operational transformation. This may be because the technical hurdles are high and new enabling technologies are not sufficiently mature, but the lack of success does raise a question about the government's ability to spur innovation.

Concerning cost, the key issue is whether cost control efforts are likely to be successful when the government relies on a single launch provider. The government clearly has a need for assured access to space. However, relying on a single provider may put the government in a weak negotiating position to contain launch costs and the launch provider could conclude that a higher profit margin on fewer, exclusively government launches is a more plausible business model than pursuing the uncertain and relatively small commercial satellite launch market.

The government would also have to consider the benefits of sustaining two families of launch vehicles, as it does today with ULA, against the benefits of only having one launch provider. The risk catastrophic failure might be deemed insufficient to justify the additional cost, or might be offset through some international cooperative agreement.

(D) Option Set IV: Enhance Demand for Launch

One of the key factors that has shaped the launch industry is the relatively sparse demand for launch. In the late 1990s, the expectation of significant commercial demand for launch led the government to support two launch vendors, but when that demand collapsed, neither U.S. vendor was economically viable on its own. Many observers note that limited demand means a low launch rate, inefficient operations, and a fragile industrial base. While the commercial satellite industry has inadequate access to launch capability today, the lack of demand may inhibit the development of a launch market that can more adequately provide that access.

One approach, therefore, to improve cost-effective access to the launch market for commercial satellites is to enhance demand, which in turn could enhance the development of new launch sources and a healthier launch market. Rather than focus directly on supply, the government in this approach would focus on policies and practices intended to diversify the type and increase the number of payloads launched. Government officials, including the Acting Director of the Office of Space Commercialization at the Department of Commerce, have publicly supported enhancing demand as a way to promote and aid the commercial sector.[83] The Air Force's FY 2011 budget request also continues the commercially hosted on-orbit Wide Field-of-View technology demonstration effort. This commercial partnership is an important example of how the U.S. government could continue to increase demand for launch.[84]

Enhancing demand could involve efforts to encourage new applications of space technologies, reduce the complexity of satellites, lower satellite costs, shorten development times, and explore architectures that focus on large constellations of individually less capable satellites (as opposed to few constellations of very capable satellites). All of these approaches could result in a larger

[83] "New Approaches to Commercial Satcom Procurement: Fulfilling the Needs of the USG and DOD"

[84] Gary E. Payton, *Military Space Programs in Review of the Defense Authorization Request for Fiscal year 2011 and the Future Years Defense Program: Hearing before the Senate Armed Services Committee, Strategic Forces Subcommittee,* 111th Cong., 2nd sess., March 10, 2010.

number of launches that, in turn, could stimulate the launch community to meet the increased demand, broaden the industrial base, reduce launch vulnerabilities, and ultimately improve launch access for commercial customers.

(D.1) Possible actions

To encourage new commercial applications of space technologies, the U.S. government could:

Pursue integrated policies to reduce the barriers to market entry. The development of new economic applications for space technologies could be one key to enhancing demand for launch, but space operations are expensive and early return on investment is often unlikely. Prospects for any commercial activity in space would rest on economic analysis by industry interested in making a profit. Some of these prospects devolve to a "chicken and egg" issue—low cost access to space and more advanced space technologies enable such developments, but without commitments from those interested in pursuing commercial opportunities that might drive launch advances, they are less likely to be pursued. The government could pursue policies to encourage expansion of space commerce to help move past this conundrum. These might entail various means of providing a more positive business environment; for example, offering tax incentives or limiting liability. Enhanced government research and development for potential commercial space applications might also be part of this approach.

One important aspect of this approach could be renewed government interest in and enhanced research and development funding for low cost access to space. The government has pursued such initiatives in the past, without notable endurance or success. If the cost of access to space were to be significantly reduced, the business case for space ventures might also improve.

To reduce the size, complexity, and cost of satellites, the government could:

Disaggregate payloads. One of the key cost and schedule drivers for space programs today is the integration of very complex technologies on multi-mission satellites. The Mobile User Objective System (MUOS) satellite program, for example, is suffering delays because of difficulties integrating two payloads.[85] Separating payloads into smaller, less complicated satellites could avoid at least some integration challenges, lower schedule risk, and reduce satellite development costs while expanding launch opportunities.

More aggressively pursue Operationally Responsive Space (ORS). ORS is an effort within the Department of Defense to develop enabling technologies and a concept of operations that more effectively meet the military needs of joint force commanders. It focuses in part on agility with current space assets, but also concentrates on developing the ability to meet such needs with responsive development and launch of smaller, less complex satellites based on proven technologies. This would shorten development times and standardize key space hardware, such as satellite buses that enable lower-cost

[85] Inside the Navy, March 29, 2010, p.1.

production. Low (or at least lower) cost launch would be key to ORS success.[86] The effort is very modestly funded today; more aggressive funding could lead to more rapid application of some ORS concepts and technologies.

To enhance demand for existing commercial satellite services, the government could:

Explore new contractual arrangements for commercial satellite services. In the past, the government purchased commercial satellite communications largely on the spot market. This has been an inefficient and expensive way of acquiring such capabilities, since satellite operators charge a premium for unplanned business for which they they cannot presume future business. In the future, the Defense Information Services Agency (DISA) of the Department of Defense intends to procure such services using longer-term contracting. The Future COMSATCOM Service Acquisition (FCSA) program uses a number of contracting vehicles to acquire both fixed site and mobile communications from commercial satellite communications companies.[87] The new approach would theoretically allow the government to acquire more communications for the same amount of money. Commercial satellite communications sell principally to commercial customers, but the government share of business with these companies is substantial (the maximum in these companies is about 20 percent today), and DoD has a voracious and growing appetite for communications. Depending on the volume of business, this new approach could translate to additional satellites to meet new demand, and thus to greater demand for launch services.

Another factor that could contribute to this approach is NASA's cancellation of the Ares/Constellation program. In the near term, this action has been disruptive. NASA was a consumer of components and services provided by the space industrial base. In the absence of that demand, companies are uncertain of future business, and overhead charges are now allocated solely to DoD. Thus DoD launch costs could rise in the near term. In the longer term, however, NASA research and development funding and planned reliance on commercial launch vendors rather than its own launch vehicles could translate to better performance capabilities and more launches for current launch providers and new market entrants such as Space-X. Additional launches could translate to higher production rates, lower cost, lower launch prices, and indirectly, to better access to launch for commercial satellite launch customers.

(D.2) Potential benefits

Potential benefits from a demand-focused approach include lower launch costs and prices stemming from a higher launch rate, and the potential development of new launch vehicles to meet higher demand. This could result in a more robust, less brittle industrial base and a launch

[86] See, for example: National Security Space Office, Department of Defense, "Plan for Operationally Responsive Space: A Report to Congressional Defense Committees," April 17, 2007, http://www.acq.osd.mil/nsso/ors/Plan%20for%20Operationally%20Responsive%20Space%20-%20A%20Report%20to%20Congressional%20Defense%20Committees%20-%20April%2017%202007.pdf.

[87] Michael A. Taverna, "Government Satcom Procurement Shifting," *Aviation Week and Space Technology*, April 2, 2010, http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=space&id=news/asd/2010/04/02/03.xml&headline=Government%20Satcom%20Procurement%20Shifting.; Defense Information Systems Agency, "Commercial SATCOM Update," April 2009.

sector less prone to catastrophic consequences in the event of a launch failure. Should concepts such as disaggregation and ORS succeed, much larger numbers of smaller launch vehicles or a modest increase in larger launch vehicles launching multiple satellites could be used to meet enhanced demand. In either case, commercial access to launch could be enhanced.

(D.3) Potential challenges

A demand-focused approach would entail overcoming significant challenges. Enhancing demand is clearly a long-term approach, and would likely have only limited impact in meeting near term requirements for improved launch access. Focusing on enhanced demand could involve a substantial restructuring of the space industry, a process that could be long and generate significant institutional resistance both from government and commercial centers with interests in the current structure and ways of doing business.

At least two significant technical hurdles would have to be overcome. First, any approach that requires far more launches than the United States conducts today depends critically on lowering the cost of launch. How low technology and streamlined operations can drive those costs[88] and how dependent the effort is on the development of small launch vehicles remain open questions. The economics that drive launch providers may still point toward large, multi-payload launch systems to launch smaller satellites, rather than multiple small space launch vehicles. Second, for some time smaller satellites are likely to be inherently less capable than larger satellites. The ability to develop and package operationally-usable, and (especially for the commercial world) economically viable payloads into smaller satellites will be critical to this approach. The market has obviously not spoken yet, and the economics of various space applications—for example, communications—may still point to large satellites. One leading indicator of this is that while the number of launches remains modest and stable, launch weight and volume has consistently increased over the years, both in the aggregate and per satellite.[89] Furthermore, small satellites are inherently incapable of some applications (e.g. large aperture telescopes), so the need to build and sustain large launch vehicles will likely continue.

[88] Current U.S. medium/heavy launch vehicles still cost more than $100 million; current light launch vehicles cost about $20-25 million. Space X hopes to launch for less than half of those costs. See Space Exploration Technologies Corporation, "Falcon 9: Pricing and Performance," http://www.spacex.com/falcon9.php#pricing_and_performance.

[89] Commercial Space Transportation Advisory Committee, Federal Aviation Administration, *2009 Commercial Space Transportation Forecast*, 27.

PART IV. Evaluation Criteria:

While the above consideration of the option sets for improving commercial access to space includes a discussion of potential benefits and challenges, CSIS has not completed a formal evaluation of them. Such an evaluation is a necessary part of any decisionmaking process.

The following evaluation criteria provide a sound basis for assessing the options sets:

(A) Reliability

Reliability (a prerequisite for *mission assurance*) of the commercial space launch vehicle is a keyfactor in the evaluation. CSIS will assess the near- and longer-term implications of each option to determine the extent to which it would maximize:

- The efficient use of the launch infrastructure and improved launch processes that reduce set-up/dwell time and increase potential launch volume both overall and at individual launch facilities.

- Safe and effective range throughput (*op tempo*), potentially resulting in increased skill levels within the launch team, reducing technical risks.

- Responsiveness to changes in demand. The ability to adapt consistently and effectively to unexpected demand increases or decreases would have positive economic and safety implications.

Reliability considerations also include the extent to which the option would minimize:

- The probability of technical failures that could cause catastrophic destruction of the launch vehicle. The consequences of such a failure are broader than just loss of the individual hosted satellite(s) and the resulting lost-payload financial and opportunity costs. Failure also could delay planned future launches until root causes are identified and corrective action determined and implemented.

- The potential impact of natural or man-made disasters. Geographical concentration of space launch facilities in one or a few physical locations can make assured access to space more vulnerable to disruptive events such as hurricanes, earthquakes, fire, or explosion.

- Schedule disruptions arising from the higher priority placed on national security and civil (NASA) payload launches. Historically, national security payload launches have been especially difficult to schedule accurately, due to chronic delays. Schedule unpredictability has made it difficult to ensure that lower-priority commercial payloads can be launched from common launch facilities, as planned, in accordance with customer requirements.

- The risk that a foreign government could delay or deny space launches carrying payloads important for U.S. government applications. This criterion addresses the ability of a foreign government to delay/deny, the likelihood that delay/denial would occur, and the significance of the impact, if it did occur.[90]

(B) Security

This criterion addresses the extent to which the option would facilitate:

- Appropriate launch vehicle or payload technology dissemination.
- Limiting potential compromise of satellite performance.
- Improvement, protection, and preservation of the industrial base as necessary to:
    - Sustain essential industrial capabilities (personnel, technologies, or facilities) necessary to develop, design, produce, and support satellites and launch vehicles. National security/national sovereignty may require that the United States create and sustain certain "essential" industrial/technological capabilities necessary to develop, design, produce, and support satellites and launch vehicles needed for key U.S. government applications. In this context "essential" industrial and/or technological capabilities would be: those key to achieving current/projected performance, cost, and/or schedule contractual requirements; those on which military superiority depends; those based on important emerging technologies; available from few reliable sources; and/or those which would be difficult, time-consuming, and costly to reconstitute, if lost.
    - Mitigate risks associated with incongruent strategic interests between the provider and the U.S. government. Such misalignment could lead to the evolution of space- or launch-related technologies and products in a direction inconsistent with U.S. government needs.

(C) Affordability

Launch prices can be market-driven, not cost-driven. This criterion, therefore, reflects the near and long-term option implications on launch vehicle cost and price, including the likelihood that the option would lead to:

- Technological innovation that would improve reliability or performance, facilitate multiple trips to space and return, and/or reduce costs.

[90] For example, the Department of Defense is dependent on foreign sources for many products used in important military applications, and foreign dependency certainly meets the "ability" test. However, to date, published DoD studies (e.g., the "Study on Impact of Foreign Sourcing of Systems," January 2004) have indicated that these foreign suppliers continued to meet DoD contract requirements despite their use in "unpopular" wars. Therefore, foreign dependency does not necessarily meet the "likelihood" test.

- New, or improved existing, launch facilities, and more efficient launch processes.

- Price decreases in both the near and long terms. CSIS will examine the extent to which option beneficiaries would:

    - Decrease prices consistent with realized cost reductions

    - Have sufficient market clout to be able to manipulate prices to drive out competition. Assuming the ability to manipulate prices, CSIS also would examine the likelihood that such manipulation would occur and the significance of the manipulation, if it did occur.

(D) Feasibility

For this criterion, CSIS evaluates the extent to which the option is feasible and actionable. Considerations include:

- Consistency with U.S. government laws, policies, and objectives.

- Complexity of implementation.

- Resource requirements (financial, personnel, political).

(E) Timeliness

CSIS assesses the timeline within which the option could be implemented, and the timeline within which positive results could be demonstrated.

Part V. Path Forward:

CSIS is releasing this DRAFT report to the public just months into its research. This is an unconventional approach for CSIS, but is consistent with the CSIS charter of helping to inform and support policymakers. During the course of research and interviews for this project, CSIS became aware of as many as 29 recently completed or ongoing space launch studies within the U.S. government. While the CSIS research staff interacted with many of those involved in these study efforts, we also became aware that no one group had visibility, insight, or connectivity to all the others. As these launch study efforts remain underway and uncoordinated, the U.S. government continues to make budgetary and programmatic decisions that may have a significant impact on all sectors of space. As has often been the case in U.S. space policy, decisions made by the government have both intended and unintended consequences—sometimes to the detriment of the U.S. space industry. This report provides a broad look at the connections between commercial and national security space, the policies and dynamics that shape the space launch industry, and policy options that will shape future decisions. CSIS believes this report will provide decisionmakers with a useful overarching framework and help integrate the findings of the other reports.

With the release of this report, CSIS is offering for public comment potential option sets and evaluation criteria to improve the space launch industry. The option sets include potential policies, directives, and actions under consideration by the Administration. Moving forward, CSIS will collect, acknowledge, and consider the public comments received during the month of May, then produce a final report by the end of June that will examine the finalized option sets using the evaluation criteria. By following this timeline, CSIS expects to provide both the public and policymakers with a structure from which to make decisions and chart a path that better reflects U.S. national security interests in space and better supports a strong and vibrant U.S. space industry.

CSIS invites your written comments. Please submit to: spacestudy2010@csis.org

Electronic versions of this report may be found at: http://www.csis.org/diig/spacestudy2010

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